PROCEEDINGS OF THE
SEVENTEENTH ANNUAL MEETING
OF THE
UTAH MOSQUITO ABATEMENT ASSOCIATION

held at the

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MIDVALE, UTAH
March 13 and 14, 1964

edited by

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UTAH MOSQUITO ABATEMENT ASSOCIATION
P. O. BOX 307
MIDVALE, UTAH

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JAY R. BINGHAM, *Moderator*

COMPETING INTERESTS MUST COOPERATE FOR FUTURE USE OF WATER

JAY R. BINGHAM, *Executive Director*
Utah Water and Power Board

It has been suggested that we begin with a statement concerning the status of Utah's water resource development. Any such statement would of necessity include a reference to the fact that our water supply limitations were felt many years ago.

It is interesting to note that Document 720 of the 58th Congress, "Irrigation Investigations in Utah," by Dr. Elwood Mead expressed a concern over this limitation. I quote:

> . . . The ordinary flow of the streams . . . is already spread over more land than it can properly serve.

I would remind you that Dr. Mead's statement was published in 1904. Presently only about one-third of the irrigated lands in the state have an adequate water supply. While irrigation is the major consumptive user of water, it should be noted that the state may be diverting more water to support waterfowl than is being diverted for irrigation (5,850,000 acre-feet for waterfowl and 5,000,000 acre-feet for irrigation). More than three million acres of irrigable land lie dormant awaiting a water supply. By 1980, it has been estimated that another 750,000 acre-feet of water will need to be diverted for waterfowl. Thus, we face competing uses for our limited water supply.

The 1960 census indicated Utah's population to be 891,000. Reliable estimates predict that by the year 1980, which in terms of planning is only a short time in the future, we will have a population of 1,524,000. This population increase between the 1960 census and the 1980 estimate, in terms of percentage, will be 72 per cent. The percentage designation does not tell the complete story. In more meaningful terms, the increase represents 633,000 people.

We still have not reckoned with the full dimensions of our problem. The per capita use of water is also on the increase.

If the State of Utah is to keep pace with the national growth rate and provide opportunity for our new citizens, we must provide additional water to sustain our economy and provide the opportunities we desire for our children.

Utah is the second driest state in the Union. Utah's mean annual precipitation is 13 inches. The "dry" state of Arizona has 14 inches. The only state lower in mean annual precipitation is Nevada. By contrast, Louisiana has an average of 55 inches. National water consumption is presently estimated at 300 billion gallons of water per day. By 1980, we are certain to need 600 billion gallons of water per day. These figures suggest that in the next 16 years, we must develop an additional water supply equal to our present use.

Obviously, in this arid region, we will need to conserve and make more efficient use of presently available supplies and, at the same time, develop new sources of supply. The source of Utah's greatest potential for new water supply is readily apparent when you study the size of the surface streams in the State of Utah. The Green and Colorado river systems dominate such a study. Our greatest population and industrial density is on the west slope of the Wasatch Range and our largest source of water is in the steep canyons and rough topographic region of the Colorado.

Our right to use water from this stream was partly defined by the 1922 Colorado River Compact. At that time, representatives of the states and the federal government, failing to apportion the water to each individual state took an important initial step by dividing the water between the two basins, the Upper and Lower. Generally speaking, the Upper Basin states, of which Utah is a part, were granted the right to consumptively use 7.5 million acre-feet of Colorado River water. Fortunately, in 1946, the states of the Upper Basin were successful in dividing the water granted by the 1922 compact. This division, made on a percentage basis, entitles Utah to 23 per cent of the Upper Basin's share or 1,714,000 acre-feet.

Presently the State of Utah is using 533,000 acre-feet of its Colorado River allocation or, in terms of percentage, our use amounts to 31 per cent. We are inclined to compliment ourselves on successes we have had in securing authorization of the Colorado River Storage Project and, while it represents a tremendous accomplishment, this project will result in 397,000 acre-feet depletion to the Colorado River or, expressed another way, 23 per cent of our allocation. This means that with the completion of the Central Utah Project, which is still years away, the State of Utah will then realize only 54 per cent of its allotment in the Colorado.

Each passing day results in greater competition for the available water of this stream. In the Lower Basin where the states of Arizona, California, and Nevada were not able to divide their share of the Colorado River water, a giant lawsuit has resulted. The amount of water allocated to the State of California by the Supreme Court is 1.2 million acre-feet less than her present uses from this source. A great test of our ability will come when we seek to further develop our Colorado River allocation in face of this tremendous overdraft by the State of California.

As we proceed with development, we can no longer consider the development of our water resource as a single purpose or independent operation. It is interrelated with many functions and activities. The sub-

ject of this conference, "Mosquito Abatement," becomes involved in this situation more and more as time goes on.

No matter how involved we get, the problems of the mosquito and man have not changed through the ages and, as an example, I quote from a publication of the Mosquito Control Subcommittee of the Columbia Basin Inter-Agency Committee as follows:

Oogak, well-known Neanderthal hunter, slapped at the mosquitoes settling on his furry hide, and grunted. A liberal translation of the grunt would be "Drat these - - - - - - - - - - skeeters!" His movement and the grunt alarmed the animals he was stalking near a waterhole, and away ran his prospective dinner. He grunted again (translation unprintable) and walked off toward his smoky cave in the cliff near the forest, kicked his youngling, and hunkered down to glower into the fire while gnawing on a dried sabre-tooth-tiger-lily root.

John Q. Publick, Oogak's great-great-ever-so-great-to-at-least-the-123rd-power grandson, slapped at the mosquitoes settling on his wrists and neck as he fished his favorite creek. "Drat these - - - - - - - - - - - skeeters!" he exclaimed. The trout in the pool saw his quick move, and immediately fled to hiding. He daubed some more patented "Skeeter-Skat" on the exposed skin, which tended to discourage the mosquitoes; but, the trout also stayed discouraged. Cursing his luck, Publick returned to his camp, dragging his flexiglass spinning rod behind him. Arrived at his tent, he snarled at his wife and told his son "Shaddap!" when asked about fish for dinner. As he flopped on the cot, Mrs. Publick began making peanut butter sandwiches for her family.

Yes, mosquitoes have been a nuisance for a long, long time. Not only to people, but to domestic livestock and to wild game also. In addititon to being pestiferous, they have been found to carry many serious diseases to man and animal. Their only benefits have been as fish food, in stimulating man's inventive genius in combating them, and in increasing the vigor of his vocabulary.

We are here today to consider "Water Resource Development and Mosquito Control Relationships in Utah."

The topic "Water Resources and Agriculture" will be treated by Lyman Willardson, a civil engineer who conducts research in irrigation and drainage for the Agricultural Research Service of the U.S. Department of Agriculture. Mr. Willardson has had experience in Latin America as an irrigation engineer. He is a native of Sanpete County with a degree of Master of Science from Utah State University and also serves as chairman of the American Society of Civil Engineers' Committee on Drainage.

WATER RESOURCE DEVELOPMENT AND AGRICULTURE[1]

LYMAN S. WILLARDSON, *Agricultural Engineer*
USDA, Logan, Utah

It is difficult to imagine agriculture in the arid west without considering water resource development. The people who first came to Utah to settle the desert began water resource development for agriculture before they built their homes. Perhaps this is the best single indication of the relative importance of water resource development in agriculture.

All of the water available for use comes from precipitation. In Utah the average annual precipitation is about 13 inches of equivalent depth of water over the total area. Of this 13 inches, 2 inches appear in wells and watercourses as usable water. The remaining 11 inches are consumed where they fall and cannot be used directly. The amount of Utah's annual precipitation that can be considered for water resource development is therefore quite limited.

Nine per cent of the available 2 inches is lost to evaporation from the freshwater lakes and reservoirs which have been created to control the water, 30 per cent evaporates from Great Salt Lake, 34 per cent evaporates from mud flats or is consumed by water-loving vegetation, 2 per cent is consumed by municipalities and industries, and 25 per cent is consumed by irrigated agriculture.

At the present time, most of the manageable water in the state is diverted for agricultural purposes. Agriculture not only diverts most of the usable water but it also consumes it. In more humid parts of the country, industries and power plants have high diversion requirements for water for cooling and washing. Cities divert large quantities of water for municipal purposes. These uses, however, are not all consumptive and most of the water is returned to the stream channels. The quantity is not greatly altered by such uses, but frequently the quality deteriorates to the point where the water cannot be reused except perhaps for transportation. Water generally remains available for some type of reuse until it is returned to the atmosphere as water vapor by evaporation or transpiration.

Since agriculture consumes most of the water diverted, it is not available for reuse. Some seepage water from canals and overirrigation returns temporarily to watercourses or the ground water supply; but it is frequently rediverted until it is consumed. Reuse of water by agriculture tends to decrease water quality. Crops consume water, leaving part of the salt behind in the soil. Repeatedly passing water through the soil leaches out these soluble salts and incorporates them in the remaining water. Water ceases to be useful to agriculture when the quality seriously affects plant growth. The Sevier River in southern Utah is completely consumptively used, principally by agriculture.

At the recent Agriculture and Industry Conference held in Salt Lake City, Governor George D. Clyde mentioned three possible sources of additional water for future development in the state. One is the importation of new water from outside sources, another is the rehabilitation of waters that have already been used to restore their quality, and the third is the greater efficiency in use of our present water supplies.

Importation of water is almost self-explanatory. For example, Utah has an underdeveloped share in the waters of the Colorado River, but use of this source has not been extensively developed. This water is relatively inaccessible because of its location in the bottom of a deep canyon in a remote and undeveloped part of the state. Economic values will have to change or

[1] Contribution from the Soil and Water Conservation Research Division, Southwest Branch, Agricultural Research Service, USDA, and the Utah Agricultural Experiment Station.

development will have to be located near the water to make its use feasible by present standards.

Rehabilitation of water is concerned with treatment of sewage or saline waters to improve their quality. Often these processes are too expensive to be economic for agricultural uses and rehabilitation is not feasible. Even after such reclamation has been effected, such water must be pumped to higher locations to be fully useful. Partial rehabilitation and use in situations which have lower quality requirements is already being practiced in the state. One municipality is irrigating a park with properly treated sewage effluent.

Improved efficiency of use of our present water supplies is the third possibility for making new water available for development. Research is under way on the suppression of evaporation from lakes and reservoirs. Methods of paving or water-proofing watersheds are being tried which will produce runoff from low rainfall areas. Industries are treating and recirculating water until most of it is consumed. Economical methods of destroying or changing water-wasting vegetation are being sought to release additional water for use. These efforts will all help to make more water available.

Future water resource development in Utah will undoubtedly cause changes in the present pattern of water use.

About 90 per cent of the controllable water is presently owned by agriculture. Agriculture is on the low end of the scale of economic competition, and, therefore, stands to lose part of its hold on the water supply. Communities and industries commonly take over agricultural lands and the associated water rights. Farms have been purchased to obtain the water rights associated with the land. These lands are taken out of production because without water they have little agricultural value.

Careful thought needs to be given to the question of whether agriculture should be maintained at its present level as the water resource which now is largely controlled by agriculture is developed. There seems to be little doubt that the amount of water available to agriculture will decrease if present trends continue. Economic forces will undoubtedly cause more efficient use of water by agriculture.

Efficiency in the use of water by agriculture is directly related to mosquito production. A study of this particular subject in Montana showed a high correlation between an increase in irrigation efficiency and a decrease in the number of mosquitoes produced. The answer to mosquito production from irrigated agriculture seems to fall right into place with the Governor's suggestion of higher efficiency of use being a source of additional water. This would provide a double benefit — more available water and fewer mosquitoes.

This suggestion is not without its problems. Although there is a double benefit, the question remains as to who will pay for the increased efficiency. Improvements in equipment and additional labor necessary to improve irrigation efficiency increase costs. In some cases these improvements result in greater net returns and so are economical for the irrigator. If they are not economical, changes will be difficult to make.

The water now being held by agriculture is probably the most economical source for any new development. It is conveniently located and in general is of high quality. A simple solution to the problem of water for new resource development would be to consider agriculture a custodian of the water until it is needed for some other use of higher economic value. Agricultural water rights could then be purchased for development as needed. If the associated land were not taken out of production, the remaining water could be applied to a relatively larger area and the maximum economic efficiency would automatically be reached. If agriculture is maintained at its present level or is expanded through further development projects, then other alternatives will have to be considered.

At Utah State University the term "sequential use" has been used to describe multiple reuse of the same water. This type of efficiency is already being practiced to some degree in the state. Reservoirs in the mountains originally developed by agriculture are being used for fishing, water sports, and other water-associated recreation. The water is passed through hydroelectric plants for power generation and then it is diverted for agricultural, municipal, and industrial uses. That part which is not consumed finds its way into the lower areas of the basins where it is finally consumed by evaporation or furnishes a habitat for wildlife and is an additional source of recreation. Such sequential use of water can hardly be called inefficient and is highly desirable in an area with a limited water supply. Water resource development problems, therefore, may be only proper organization and planning.

Present sequential use patterns have largely grown by accident rather than by design, but forces are at work which may tend to alter this pattern. Each user of water in the sequence wants to be first. Most users want more water of a higher quality than they actually need. As these users become more strongly identified and more economically powerful, they are able to assert their position and become the first and sometimes the only user in the sequence. A municipality, for example, may construct a reservoir for a water supply. It may close the reservoir to fishing, swimming, and boating and after passing the water through its water and sewage system may leave it at such a low elevation and of such a quality that it can only be wasted to the atmosphere by evaporation. In some instances water which was or might have been used to make land productive is now purchased and stored permanently in reservoirs for fish propagation. Water which could be diverted for agriculture is now being taken directly from its source to the lowest point in the river system to provide for waterfowl habitat. Such uses out of sequence may be nonproductive of new wealth and so are relatively wasteful of our only really basic resource — water.

The place of agriculture in water resource development in this state is one which should receive full and rational consideration. The productive value of the four million acres of irrigable land in the state (one million are presently irrigated) should not be over-

looked. Future allocations of water should take the basic productivity of the land into account.

If future users of water can take their logical place in the sequence or can develop their source of supply from water that is presently being wasted to evaporation from the freshwater surfaces, the Great Salt Lake, and from mud flats and nonproductive vegetation, the water resources of the state will effectively be increased. If, on the other hand, the new developments merely replace agriculture, one of the basic productive resources of the state will be diminished.

Nonproductive uses and users who can afford to pay more for water than agriculture might fill their new needs for water from the more expensive sources such as evaporation prevention or rehabilitation. Increasing the cost of water to agriculture will only increase the cost of food. Agriculture should become efficient in its use of water to the limit of its ability. If these things are done not only will there be fewer mosquitoes, but a higher standard of living will be possible for all the people of the state. With proper long-range planning, optimum use can be made of the water resource by all uses and users.

Mr. Bingham:

Our next speaker reverses a trend which has concerned the State of Utah for many years. Here we have a man who came originally from California, secured his Bachelor of Science degree in Forestry and also his Master's degree in Forest Recreation from the University of Idaho. He is now nearing completion of his Doctor's degree in Forest Recreation at the University of Idaho. He serves as extension forester part time and also as Professor of Forestry at Utah State University at Logan. John Hunt, extension forester, will speak on the topic, "Water Resources and Recreation."

WATER RESOURCES AND RECREATION DEVELOPMENT

JOHN D. HUNT, *Extension Forester*
Utah State University

Chairman Bingham, fellow panel members, ladies and gentlemen: It is indeed a pleasure to address this group. To date I had thought my only involvement with mosquitoes would be our association during various fishing trips in the summer.

Although my presentation will not be directly related to mosquito abatement, I assure you that this awesome little creature plays an integral part in outdoor recreation.

Water resource development and recreation is a very timely subject. In fact, it is so timely that it has been the major topic of "cussin' " and discussion of numerous conferences in recent months.

In the evolution of resource development and management, resource uses tend to give way to other uses as society's values change. Presently water resource development and use are facing a new element in their dynamic evolution. Water is in great demand for recreation. Possibly this will change, but in the foreseeable future we must consider recreational use of water.

At the recent Agriculture and Industry Conference held in Salt Lake City, assistant commissioner of the Bureau of Reclamation William I. Palmer discussed reorientation and redirection of the reclamation program. In eight phases of this re-emphasis, he stated number one as being "increased consideration of recreation as a major project function." Generally speaking most reclamation projects have become popular recreation areas; however, this activity has seldom been recognized in the allocation of project costs. Mr. Palmer discussed what action was being taken to make the recognition of all uses more equitable.

At this same conference, Congressman Aspinall also pointed out the fact that "increased attention must be given to policies relating to newer uses of water, such as recreation, fish and wildlife."

W. W. Dresskell, regional director of the Bureau of Outdoor Recreation, devoted his entire presentation to "Water Resources and the Future of Outdoor Recreation." Mr. Dresskell said, "The growing demand for water throughout the nation is widely recognized and well publicized. While the population will double by the year 2000, demands on our water resources are expected to triple." He went on to say that, "I need hardly remind this group that all of the traditional, and sometimes competing, demands on our water resources — for navigation, flood control, municipal and industrial water supply, hydroelectric power, irrigation, fish and wildlife — will increase. But I do want to take this opportunity to discuss a relatively new factor that has entered the picture and has greatly increased the complexity of the problem. This is the growing importance of recreation in American life and the tremendous demand of the American people for water-based recreation."

Why this increased concern for recreation demand in recent years and specifically in regard to water resources? Looking first at recreation in general, one sees numerous factors which have contributed to an increase in outdoor recreational activity.

Increased leisure time has afforded more opportunity for outdoor recreation. In 1950 the Federal Inter-Agency Committee on Recreation reported that in 1900 about 15 per cent of an individual's time was devoted to leisure. This excluded sleeping and eating, which in many cases could be a form of leisure. By 1950, this figure had jumped to 27 per cent. And if these data were fitted to a straight-line regression curve, projection would indicate that in the year 2000 nearly 40 per cent of the individual's time would be devoted to leisure. Undoubtedly this is not the true picture since many unexpected and changed conditions have occurred since 1950. There is no question, however, that leisure time has and will greatly increase.

Increased urbanization is another factor contributing to increased outdoor recreation demand. Urban life tends to create the desire for occasional visits to outdoor areas away from the hustle of the city.

Increased travel through improved automobiles and highways has opened many new outdoor recreation opportunities. It was not too many years ago that a

trip of 150 to 200 miles was a major undertaking. Today, a one-day outing may easily cover this distance. In fact, our improved highway system is becoming so effective in moving traffic that it is nearly bypassing recreation. John Steinbeck, in discussing our high-speed highways in his latest national best-seller, "Travels with Charley," graphically pictures this situation when he said, "These great roads are wonderful for moving goods but not for inspection of a countryside. You are bound to the wheel and your eyes to the car ahead and to the rear-view mirror for the car behind and the side mirror for the car about to pass, and at the same time you must read all the signs for fear you may miss some instructions or orders." He concluded that, "When we get these thruways across the whole country, as we will and must, it will be possible to drive from New York to California without seeing a single thing."

Steinbeck's observation may be true; however, these improved highways are instrumental in making it possible for great masses of people to readily move to major outdoor recreation attractions.

Disposable income has increased in recent years with a more than proportional decrease in the cost of recreational equipment. In its report to the President and Congress in 1960, the Outdoor Recreation Resources Review Commission stated that "in 1959 the total estimated dollar value of purchases of major sporting goods was just under $2 billion. Of this, approximately $1.5 billion was for items related to outdoor recreation."

Other changes in our society are causing increased outdoor recreation activity. The education level is rising. Younger and older groups with more leisure time are receiving more income. Life expectancy is increasing, and by the year 2000 we may live to be 100 years of age. With reduced retirement age, this will create phenomenal amounts of leisure time. Outdoor recreation will undoubtedly have to absorb the major portion of this time. Finally, outdoor recreation is even becoming a status symbol.

All of these factors seem to indicate a more progressive, prosperous society — a brave new world or Utopia. However, from the resources point of view this is not necessarily so. With an expanding society, the demands on our natural resources become more acute. Natural resources no longer are looked to for "food and fiber" alone but "fun" has been added to the list of demands.

Concerning water resources and recreation, a more perplexing situation appears. Not only is the demand for outdoor recreation activity increasing in general, but the trend is specifically toward more water-oriented recreation. Besides water activities, most other outdoor recreation activities are enhanced if located near water.

The ORRRC stated that 44 per cent of the American public preferred water-based recreation activities above all others. And in the year 2000 swimming will be the most popular activity, even more popular than auto driving for pleasure. The Commission found that approximately $2.1 billion was spent at the retail level for boats and boating equipment during 1958. Fishermen spend nearly $3 billion annually on their sport. The Commission reported that there is now one boat for every seven cars on the road.

Mr. Walt Hopkins, chief of the Forest Recreation Research branch of the U.S. Forest Service, told participants at the Western Resources Conference in Fort Collins, Colorado, last August that "in 1959, a new and disturbing national record was reached when more people were killed over the Fourth of July weekend in boating accidents than in car accidents." The writing on the wall plainly indicates outdoor recreation is growing in leaps and bounds with water-based activities playing a major role.

Although Utah lies solidly in the middle of our country's most arid region, she is not without her share of outdoor recreation attractions and activities. There is no need to discuss recreation in general as the nearly 5,000,000 tourists who visit Utah annually attest to the fact that Utah's natural resources are relied upon heavily for outdoor recreation. This figure excludes the millions of visits made annually to Utah's out-of-doors by the local populace.

Looking specifically at water-based recreation, we see many outstanding figures. In 1963, 13,797 boats were licensed. This is nearly one boat for every 12 families. Boat-ownership in 1963 increased nearly 75 per cent over the 8,000 boats in 1959. Approximately 160,000 resident anglers trek to Utah's streams and lakes each year. This excludes the many nonresident anglers who cast a line for the elusive trout in Utah waters. Research being conducted by Utah State University at Bear Lake indicates that water-based recreation is an integral part of nearly everyone's outdoor activities.

Two hundred parties of local users and tourists were interviewed during the summer season of 1963. One out of six owned water skis, two out of three owned fishing equipment, and one out of six owned a boat. When these groups were asked about the activities in which they participated during that year, the answers indicated that three out of five swam, two out of five fished, one out of three boated and one out of four water-skied.

At this point one would conclude that water resources and outdoor recreation are keyed specifically to bodies of water. This is misleading because, when we talk about water resources and recreation, all activities must be included since they have an impact on water resources in one way or another. As mentioned earlier, most recreation activities are associated with water. Camping, picnic, and hunting areas are fairly inadequate without a water association.

Water per se is only one part of the picture since the watershed provides the basis for a water supply. Therefore, when we speak of water and recreation, the picture is not complete without viewing the role of the watershed. It would be safe to say that nearly all outdoor recreation activities are performed on water or a watershed important to some community or industry.

Therefore, the water resources of Utah are influenced by every outdoor recreational pursuit. With this tremendous impact there must be problems, and, as

Professor S. Ross Tocher of Utah State University pointed out at the Fifth Annual Western Resources Conference in Fort Collins, Colorado, if water resources and recreation are to be compatible and provide maximum benefits to society, watersheds must remain unimpaired, water purity must be maintained, and high-quality recreational opportunities be provided.

With increased population the pressures and problems related to water resources become more complex. The demand for water for all purposes increases. In order to insure a continuing supply of high-quality water for all uses, various controls, regulations, and management techniques must be activated.

Although recreation is not a consumptive use of water, if improperly managed it can result in conditions detrimental to a good quantity and quality supply. The watershed is probably influenced more by recreation than the water itself. That is to say that recreational activities are more prone to directly damage the watershed than the water.

Problems of land impact become more critical with increased numbers of users: vegetation can be broken and stamped to oblivion; soil can be removed from tree roots leaving them gnarled and exposed; vegetation dies and an integral part of the watershed is damaged. Compacted soil prevents proper water infiltration and movement. Studies done by Meinicke in 1927 in the California redwoods showed that visitor-use had resulted in compacting the soil to a depth of 18 inches. Reproduction was halted and infiltration inhibited. The lack of vegetation and the compacted and exposed soil promoted erosion and water loss.

Soil pollution is a new and alarming condition that is becoming increasingly noticeable. Human wastes, soapy and greasy water, and various other solutions are killing vegetation and clogging soils. With more people roaming the hillsides, the fire hazard is increased. Man causes nearly 95 per cent of the forest and range fires in the United States. More people in the fields and forests increase the probability of more devastating holocausts.

Each fall thousands of hunters take to the backwoods in search of deer, elk, and other game animals and birds. Dirt roads become running rivers of mire and silt. These activities are evidenced the following spring and summer by deep gullies and washed-out roads.

New and more intensive management techniques must be initiated in an effort to curb damage to watersheds from recreational use. Fertilization and irrigation will be necessary in high-density-use areas to combat impact and contain and improve vegetation growth. Roads, trails, camping areas, and picnicking areas will need to be paved or covered with some material which will reduce soil loss. Barriers and fences will need to be employed to keep users within designated areas and away from fragile soils and vegetation. A relatively new technique for directing users away from fragile areas is the planting of offensive vegetation. In this manner the user is controlled without obvious measures which may detract from the outdoor experience or may even create a reverse action more damaging than if it had not been employed. New and more rigid fire laws and regulations must be developed and enforced. In high-fire-hazard areas it may even be necessary to close the area during periods of extreme fire danger.

Where large areas of private land, summer home developments, or resort and service accommodations are involved, zoning regulations must be developed. In fact, the time has come when each county in Utah should seriously consider zoning laws and regulations related to recreational development and activity.

Finally, in the future, direct restriction of use in certain areas may become necessary. To protect the land and to insure the quality of the recreation experience, numbers of visitors may have to be limited. The advisory board on wildlife management appointed by the Secretary of the Interior (Blue-Ribbon Committee on National Park Management) supported this idea when it said, "If too many tourists crowd the roadways, then we should ration the tourist rather than expand the roadways."

Turning to the water, we find an altogether different set of problems. The primary problem is one of water pollution. Water pollution is a threat to our nation and state which, in all probability, could lead to their deterioration and downfall if not halted. Outdoor recreation is not yet a great contributor to this problem; however, with the increases foretold it could easily become more guilty of contributing to the desecration of our country's water supply. Refuse resulting from recreation activities can easily find its way to water. Garbage, feces, and many a fishhead can be found in our bodies of water. The increased number of summer homes bordering larger lakes and rivers may contribute to pollution if stringent controls are not adhered to. To prevent pollution and water damage by the recreationist, we must employ many of the techniques necessary for the protection of the watershed. Modern facilities for disposing of refuse must be constructed in recreation areas and near water areas. Undeveloped shorelines along lakes and streams must be developed or restricted to certain uses.

Finally, if recreation activities are to serve their purpose, they must be kept of high quality. Even with recreation, quantity alone will not suffice. Conflicts between swimmers and boaters must be resolved. Solutions must be found in situations where private ownership restricts access. Facilities and activities of a wide spectrum must be provided to satisfy the demands of a heterogeneous population of recreationists.

An intensive effort must be made to manage our water and outdoor recreation resources in a compatible manner to provide maximum benefits to our society. High-quality recreation experiences must be provided and extreme care taken to prevent damage to our forest, range, wildlife, soil, recreation, and water resources.

Mr. Bingham:

The next speaker is presently head of the Department of Civil Engineering at the University of Utah; additionally, he has served as a member of the Water Pollution Control Board for the State of Utah since the Board's beginning in 1953. We are especially pleased

to note that Grant Borg has been named the recipient of the National Water Pollution Control Association's "Arthur Sidney Bedell Award" for service in the field of pollution control for 1964. We are pleased to have Mr. Borg discuss "Water Pollution and Treatment of Polluted Water."

WATER: IT CAN MEAN LIFE — OR DEATH

GRANT K. BORG, *Professor and Head*
Department of Civil Engineering, University of Utah

A clean, safe water supply means life. A polluted water supply means death, not only to the community but to the individual as well.

Each of us thinks of water supply in different terms. These terms are usually on the basis of use. The farmer looks to an adequate supply of water for irrigation, the industrialist wants water for his manufacturing plants, the sportsman wants streams that are clean where fish and wildlife may flourish. But all of us must look to the domestic water supply as basic to our way of living.

Water is community wealth. And, if through water pollution we ruin the water for irrigation and for industrial purposes, if the fish and wildlife are killed, our recreation spots placed off-limits because of health hazard, and we run the risk of epidemic because of polluted domestic supplies, we are reducing that wealth.

The problems of water supply and waste disposal cannot be dissociated, because the human animal is continuously striving to pollute all of the water with which he comes into contact.

It is estimated that there are now some three billion people on this earth and that by 1980 there will be four billion, and we in the United States are doing right well to help with this population explosion. But we are running out of water — that is, clean water. Where are we to find new nonpolluted sources; and how are we to keep our present sources clean, when we return to the streams, lakes, and reservoirs, which are sources of supply for other people, so much waste that is untreated?

You don't believe we are running out of water? Only a few years ago there was a drought in one of our midwestern states. Their water supply dwindled to almost nothing, and as a last desperate measure the sewage from the town was treated by conventional methods, impounded, diluted with what fresh water was available, returned to the water-treatment plant, and then put back into the water mains. It is estimated that the water went through six of these complete cycles in that one summer. Every 30 days the water came out of the tap again.

Water is a commodity that we expect to have available just like the air we breathe. We expect that it will be of good quality, that it will be safe, and that there will be enough to fill our every need.

Let me pose to you a question with two parts: How much is life worth to you (1) if the life is that of a person close to you, or (2) if the life is that of a migrant you have never seen?

I would not attempt to answer or argue these questions, but were you to be confronted with each situation, I think there would be no doubt concerning the number of tears shed in each instance. Now, you should realize that a glassful of water entering the water system does not choose its user — it does not choose you, me, or the migrant (I think we call him a tourist). Any one of us could get the "once-in-a-while" contaminated glassful. This points out the necessity for safe water all the time, not safe water part of the time.

But how often is this necessity called to your attention? Only when there is no water at the tap or only when disaster strikes and you are inconvenienced. What would happen at your home if there was no water available for 24 hours? No water to bathe, wash your hands or brush your teeth, no toilet facilities, no water to cook with and none to drink. This situation would be nothing but chaos.

What would happen if our water supplies became contaminated and three-fourths of our people were suddenly stricken with gastroenteritis, dysentery, or cholera? This again would be nothing but chaos.

Now we can always tell if there is enough water at the tap to fill our needs. But is it safe? It may be clear, cold, sparkling, and taste good — but is it safe? You can see dirt, sticks, leaves, and worms in a glass of water, and you can tell if the water tastes bad or has an offensive odor; but you can't see or taste bacteria or virus. Yes, is the water safe? This is the question that the sanitary engineer wants to say yes to every minute of every hour of every day. But unfortunately this is not always possible. Safeguarding the municipal water supply seems to be of secondary interest to many people. Not the waterworks employees, but the ordinary citizen. Let us take one example that is pretty close to home — Big Cottonwood Canyon. The canyon is ideal for hunting, fishing, skiing, picnicking and for summer and winter homes. It is close to the city and is accessible the year around. Many thousands of people visit this canyon each year. The stream in the canyon is one of the sources of water supply for Salt Lake City. It contributes about 25 per cent of the total yearly demand.

As one enters the canyon he can see an imposing set of structures in the canyon floor. A large sign informs him that this is a water-treatment plant for Salt Lake City. A little farther up the canyon is a sign that says, "This stream is a part of the Salt Lake City water supply. Keep it clean. No horses allowed. Keep dogs on leash." There are many more of these signs in the canyon to remind one that this stream is a source of drinking water, but signs do not bother some people. On one occasion I made a special trip up the canyon to see how many violations I could observe. Here they are:

Two girls riding horses in the stream.
Five members of a family from Salt Lake City wading in the stream.
Eight instances of people washing their picnic utensils in the stream.
Fifteen instances of people throwing garbage into the stream rather than using the garbage cans.
Fifty-two separate parties using the stream to cool drinks and watermelons.

Eight dogs running loose, three in the stream.

One man cleaning the fish he had caught, throwing the entrails back into the stream.

In four hours I observed 89 separate acts of polluting the water we drink. This — in spite of the fact that the signs say "don't do it" and in spite of the fact that water department employees and health officers are patrolling the canyon, warning and sometimes arresting flagrant violators.

The city water department, recognizing the sanitation problems involved in multiple-use of watersheds, has provided toilet facilities all through the canyon. Now, not only do some people bypass these facilities, but they chop them down and use the wood for campfires. Salt Lake City is having to replace the wood structures with pre-cast concrete.

Oh, yes, you say there is a water-treatment plant at the bottom of the canyon and that will fix everything. But, you cringed a few moments ago when I recited the experience of sewage recirculation in Kansas. What is the difference except for magnitude?

I know that I will be accused of being an anti-recreationist, an anti-winter sports enthusiast, and an anti-sportsman. Nothing is farther from the truth. There can be some multiple-use of the watersheds, but it will be incumbent upon all of us collectively and individually to be aware of what is happening. As the roads are improved, more facilities are provided and the more inaccessible areas of our wilderness are opened up, there will be more people entering the canyons to use the facilities. This will necessitate a redoubled effort to see that all of our sources of supply are not further polluted.

Now this sort of thing is happening to a more or less degree all over the United States on nearly every watershed. In addition, industry is discharging pollutants into our watercourses in unbelievable quantities. There are many municipalities still discharging either raw or partially treated domestic sewage into our watercourses. Not in Utah? Oh yes — Salt Lake City, Logan, Payson, Price, Park City — just to name the larger ones, and there are 42 smaller cities and towns doing the same thing.

It is true that some planning has been done by some of these cities to provide adequate sewage-treatment works, but it will be a couple of years before any major construction can be completed and plants put into operation. In addition to these presently sewered sources of pollution, there are new districts being created, and towns heretofore using septic tanks and cesspools are installing sewers. This will add more to our pollution problems.

Since 1952, there have been constructed in the State of Utah, 29 complete sewage-treatment plants serving 55 communities. But we have not solved the problem. Present sewage-treatment practice, which we call "complete," removes only about 85 per cent of the pollutants present in domestic sewage, so with the rapidly increasing population, and the resultant increase in sewage flow, we are barely holding the line and it may only be a few years until our waters may be more highly polluted than they are today unless we can find more efficient and economical ways for waste treatment.

In many instances the industries of Utah have seen fit to attack this problem of pollution by construction of facilities to treat wastes before they are discharged into our streams. There are, however, many industries that still discharge raw or partially treated wastes. Raw wastes from such industries as canning, milk processing, slaughtering and meat packing, sugar manufacturing, and petroleum refining are contributing a pollution load to our streams which is much greater than the total pollution contributed by domestic sewage wastes.

The combination of domestic and industrial wastes can and is impairing the use of our waterways for such uses as fishing, hunting, and recreation as well as rendering the water unusable for domestic, agricultural, and industrial purposes.

And to add to our old problems of waste disposal we have had heaped upon us the problems of trying to remove new types of waste — detergents, insecticides, herbicides, and synthetic fertilizers. In the past 20 years at least a half-million new chemical products have come into existence. We use these products and then through one means or another discharge them into our streams or underground watercourses, and then days, months, or possibly years later these products may appear in our drinking-water supplies. True, they may appear in minute quantities, but as yet we do not know what will be the physiological effects caused by ingestion of small quantities of these products over an extended period of time.

During 1960 more than three billion pounds of detergents were used in the United States. Certainly most of this found its way back into our watercourses. Not only do we have this pollution problem, but in many instances foaming of the sewage occurs at the treatment plants. In at least one instance a treatment plant was completely enveloped in a mass of detergent foam.

We know how to orbit the earth, send television pictures by Telstar, and hit the moon with a rocket. But we don't know enough to safeguard and treat our water supplies. In many places in our United States, a glass of water drawn from the tap will have a head on it like a stein of beer. Our science and engineering know-how is not far enough advanced to build treatment works that will effectively remove these wastes.

Now, when I say we cannot treat a highly polluted water and make it safe, I mean we cannot do this within our economic limit. It can be done — for a price — but I'm sure you are not willing to pay for water at a rate 10 or 15 times what you pay now.

Each water-treatment plant has its limitations as to the amount of pollution it can remove. And as the pollution level in the source rises toward the critical level which can be tolerated by the plants, we must be willing to pay more for treating the water and be willing to accept a finished water that is poorer in quality, both chemically and bacteriologically.

The cliché, "An ounce of prevention is worth a pound of cure," is especially true in the case of water supplies. To date, pollution control has largely been corrective in nature. But in addition to this kind of action, we must prevent new pollution from reaching our streams. We can then turn our attention to making

sure that the water you drink is safe every minute of every day of every year.

I am afraid, though, that even our best efforts will not be enough. So long as there is the possibility that the human animal can come into contact with our water supply sources, pollution will occur. It is going to require a major breakthrough in engineering know-how to provide enough safe water, at a price we can afford, to maintain our present economy.

What are the avenues of approach? All I can say is that the treatment processes will have to differ radically from the processes we now have. It is going to require a lot of thought, imagination, and hard work if we are to survive the impending water famine, and if we are to know for sure whether the water we do have will mean life or death to our society.

Mr. Bingham:

The subject, "Comments on Water Resource Development and Mosquito Control in Utah" will be treated by Dr. Don M. Rees, Chairman of the Division of Biology of the University of Utah. Dr. Rees is an entomologist who has a major interest in mosquitoes and mosquito control. He is President of the Board of Trustees of the Salt Lake City Mosquito Abatement District and was the first President of the Utah Mosquito Abatement Association.

COMMENTS ON WATER RESOURCE DEVELOPMENT AND USE, AND MOSQUITO CONTROL IN UTAH

DON M. REES, *Ph.D.*
Department of Zoology and Entomology
University of Utah

It is evident from the preceding papers presented in this panel that in Utah water development and use will not only continue, but will be greatly accelerated in the future to meet the needs of a rapidly growing population. It also seems apparent that our present plans for an accelerated water development program will possibly be unable to keep pace with the ever-increasing need for water for use in agriculture, industry, recreation, or to even meet the most urgent demand to provide the water required for the rapidly growing communities in this state. Fortunately, Utah has far-sighted individuals who have been able to see the urgent need for developing these water resources. This they are attempting to do through various agencies organized for this purpose. The people of this state, to provide for this ever-increasing demand for water, must extend their complete and active support to this program.

As water resources are developed and the water used and reused for multipurpose services, there is always the possibility that a considerable amount of this developed water may become mosquito-producing water. From past experience in water development and use programs in this state, I am aware that an increase in mosquito production seems to be an inevitable companion of water development and use. Mosquito control, in areas where mosquito abatement districts have been organized, is a service the people of Utah no longer expect — it is a service many of them demand. As citizens interested in water development and mosquito control, it is our responsibility to lead in the development of both of these public-service programs.

Undoubtedly in Utah there is a definite correlation between the development and use of water resources and the number of mosquitoes produced in an area. This is to be expected as we are all aware that mosquito eggs must be in water before they will hatch and that the larvae and pupae of all mosquitoes must have standing or slow-moving water in which to complete their development and emerge as adults. Therefore, it is logical to assume, and quite generally believed, that more water necessarily means more water habitats in which mosquitoes can develop and thus more mosquitoes will be produced; and, conversely, that fewer mosquitoes will be present when less water is available. This reasoning establishes a correlation solely between the amount of water present and the number of mosquitoes produced and ignores other factors equally essential for mosquito production.

It has been demonstrated that the number of mosquitoes in an area does not always increase proportionately to the increase in the water developed and used, or decline as the water supply and use diminish.

It is essential that water is present before mosquitoes can develop but the water must be standing or slow-moving to be a suitable habitat for mosquito larvae and pupae. There is also another equally important requirement essential for the production of mosquitoes. Mosquito development cannot be completed from egg to adult unless the water remains for a minimum of five days; usually development of these stages requires a week or more. Thus movement of water exludes from mosquito production all fast-flowing water such as that in streams, irrigation canals and furrows, properly functioning drains, and other moving water. It is also obvious that water in covered storage reservoirs, barrels, buckets, bottles, cans, or pipe lines where mosquitoes cannot enter to lay their eggs are not sources of mosquito production. This eliminates much of the water in an area as a mosquito-producing hazard. It is also known that many standing bodies of water do not produce mosquitoes because of certain factors present in these waters that make them unsuitable as water in which mosquito larvae can survive. As an example, mosquito larvae never develop in the Great Salt Lake since they cannot tolerate the salt concentration in the water. Another example is the egg-laying habit of the common *Aedes* mosquitoes which lay their eggs on moist soil, rather than on the surface of the water. These eggs will not hatch unless flooded with water. If the water level remains relatively constant in streams or other bodies of water, eggs on the soil adjacent to the water are not flooded and submerged in water and therefore do not hatch. Eggs of the *Culex* and *Culiseta* species are laid on the surface of suitable bodies of water. This egg laying requires water with suitable depth, protective plant cover, and a suitable food supply for the larvae. In many of these more permanent bodies of water possessing these essen-

tial characteristics, the natural enemies, predators and parasites, also find this water a suitable environment and are present in sufficient numbers to destroy most of the larvae and pupae before the adults emerge. In other instances, wave action from prevailing winds is sufficient to prevent survival of the larvae and pupae.

It would seem from the above-mentioned factors that act to prevent mosquito production in water that very little water would remain in which mosquitoes can mature. This is essentially correct; but this remaining water supply is adequate, as we are aware, for producing more mosquitoes than the public will tolerate.

The remaining water which can be considered as suitable for mosquito production can be broadly classified as natural water and used water. Natural water can be defined as those waters which have not been developed and used by man. The used waters are the water resources which have been specifically developed and used for one or more purposes.

In considering the importance of these two kinds of water as sources of mosquitoes in Utah, it has been determined that while both are responsible for mosquito production they are not of equal importance, as the waters developed and used by man are far more important in producing mosquitoes on a seasonal basis than the natural or unused water present in a region.

The natural surface water in which mosquitoes are produced is generally present in greatest abundance in Utah in the spring and early summer. This water from melting snow and spring rains accumulates along the margin of streams and in other depressions over the earth's surface where melting snow and spring rains deposit precipitation. In these surface pools large broods of mosquitoes are produced, especially species of the genus *Aedes*.

During the summer, these mosquito-producing surface pools disappear and generally do not reappear until the melting snow and spring rains create these pools the following spring. Sometimes heavy summer storms and at times accompanying floods do create surface pools that may produce mosquitoes in the summer months; but generally the water from rainfall during the hot, dry summer months does not remain long enough for the mosquitoes to complete development. Natural water channels, without man-made diversions or impoundments, produce relatively few mosquitoes after the spring freshets have subsided. In this Salt Lake Valley the water prior to its diversion and use by man flowed through natural channels into the Great Salt Lake and extensive mosquito production was confined largely to the spring and early summer.

This implies that mosquito production in Utah is largely dependent upon and attributed to water development and use by man. This was established by studies that have been made in Salt Lake County and other counties in Utah on the origin of mosquito-producing water in Utah.

It has been determined, depending on the location, that from 50 to 80 per cent of the mosquitoes produced during the season in the parts of Utah inhabited by man are the result of man-made situations which are created from the development and use of water. I hasten to add that most of these man-made, mosquito-producing situations serve no beneficial purpose and could be prevented by better planning in construction operations and greater care in water management practices. Part of these man-made, mosquito-producing situations results from a failure to understand and incorporate principles of mosquito control into construction programs. If mosquito prevention measures were better understood and incorporated into water development plans of storage and use, mosquito production could not only be reduced, it could be eliminated in many areas in Utah. This could be done with little additional expense and without curtailing the water development program in the state.

The adoption of mosquito prevention factors into the water use or management program is largely educational and can be accomplished without additional cost and in many instances with added benefits to the water user.

Mr. Bingham (summary statement):

Mr. Willardson has reviewed the means by which the State of Utah can provide water for its expanding water needs by developing new sources of supply, making a multiple and sequential use of our present supply, and improving the efficiency of application in all uses. He has pointed to the fact that the competition for our limited water supply will necessarily result in economic adjustments between uses.

Mr. Hunt has illustrated the fact that while our population will double within a few short years, our demand for water over that same period of time will triple. More leisure time and a transportation system emphasizes the growing importance of recreation. There is a strong preference for water-based recreation and this fact concentrates large numbers of people at the source of our water supply. The challenge is to provide high-quality recreation for a growing population without damage to our water-producing area.

Mr. Borg has emphasized that future water development and mosquito abatement must reckon with the tremendous amounts of pollutants that industry, municipalities, and agriculture contribute to our streams. He emphasized that pollution treatment continues to be a major problem of the future and the requirements for pollution control will increase proportionately with our industrial and municipal development. He concluded with a thought that the solution to the pollution problem lies in each individual returning water to the watercourse in as good or better quality than it was when he received it.

Dr. Rees recognized that water development is necessary to industrial growth and that it must be accelerated. He pointed to the need for a re-evaluation of the use of water and the necessity for better designs which will, with very little added costs, relieve the mosquito problem of future water development.

In final summary, I think that we all agree that future development must consider all related aspects. I feel that we would all agree that the desirable combination can be realized only through adequate planning. In this connection, we have made a significant step forward by initiating the preparation of a State

Water Plan. Such planning is the best assurance that all future needs will be considered and that complicating and costly mistakes will not be made.

I leave you with the words of Ralph Waldo Emerson: "This time, like all other times, is a very good one, if we but know what to do with it."

SOME CONTRIBUTIONS OF THE AMCA TO MOSQUITO CONTROL

JAY E. GRAHAM, *Manager*
Salt Lake County Mosquito Abatement District

The American Mosquito Control Association held its twentieth annual meeting with the tenth annual meeting of the Illinois Mosquito Control Association in Chicago, March 1–4, 1964. The purpose of this report is not to review the program or proceedings there, although such a review would be worthwhile, but rather to discuss the value of the AMCA and some of its achievements.

The contributions of the national association can be grouped into three categories. The first is the information that can be obtained either from *Mosquito News* or from attendance at meetings. The annual subscription for *Mosquito News* is only $8.00. Any conscientious manager should be able to find at least one article every ten years that would save his district $80.00 and thus pay for the publication. Actually, improvements in control worth thousands of dollars to a district can be obtained from studying *Mosquito News* or attending meetings and discussing problems with others concerned with mosquito control. The old expression that two heads are better than one is true, particularly when some of the heads belong to the world's top authorities on mosquitoes and their control. Managers who neglect opportunities to confer and discuss their problems with the best minds in their field are not doing all they can for their districts.

The second category of contribution to mosquito control is that of helping in the development or evolution of what might be termed mosquito control technology. The information and procedures that are used to control mosquitoes today constitute an involved and complex technology that has evolved over many years and is continuing to develop today. This technology concerns everything from the policies and directives of the board of trustees to dipping procedures. The chief agency at present in this development of technology is the national association and its meetings. Here ideas and experiences are interchanged, developments reviewed, and new techniques proposed for future study, experimentation, and possible use. Every mosquito abatement district in Utah conducts a program based on a technology developed in this manner. We did not invent it. We use what has been given to us. Time does not permit a complete review of all the present procedures that are evolving, but they include new insecticides, biological and cultural control techniques, and procedures that will allow us to work harmoniously with other interests such as agriculture and wildlife. The AMCA provides a forum where research workers can present the results of their efforts. This is a powerful stimulant to research and channels a good portion of the creative talent of research workers into mosquito control problems. Without support, these activities would fade and all mosquito control programs, including those in Utah, would be adversely affected. We owe a debt to the past, but we can pay it only to the future by supporting and participating in the activities of the AMCA.

The third category in which the AMCA contributes to mosquito control programs is as an active agent in control. The most recent and conspicuous example of this is the development of good working relationships with wildlife interests on a national level. The spirit of cooperation developed by the National Mosquito Control-Fish and Wildlife Management Coordination Committee has eased many problems and headaches that could have developed in Utah. Our own Utah committee is an outgrowth of the national committee, and over a period of time will be worth much money to the control programs in the state. At the present time, there is considerable discussion of the proper scope of mosquito control programs which does not appear in *Mosquito News*. These discussions will eventually resolve into a philosophy that will either include or exclude other vectors in mosquito control programs. This philosophy, developed on a national level, will then eventually determine a part of the future of Utah mosquito control programs. We are, therefore, involved whether we like it or not. We must participate and contribute. In summary I would like to reiterate that the American Mosquito Control Association contributes to mosquito control by providing information and the exchange of ideas; by being an important agency in the development of mosquito control technology and providing a forum for research workers; and by being an active agent of control on a national basis. In order to make these contributions the American Mosquito Control Association needs support from mosquito control workers in the form of membership and participation in meetings and the affairs of the association.

PLANNING — A FORERUNNER OF AN EFFECTIVE MOSQUITO ABATEMENT PROGRAM

I. DALE DESPAIN
Utah City-County Planning Consultant
Provo, Utah

As I stand before you, I feel much like the young lieutenant who was summoned to present the results of a study before a group of generals. As he came into the room, he tripped and fell head-long into the room. Embarrassed, he picked himself up, looked around and said, "I couldn't have fallen in with a better group."

The term "planning," as used in the context of this paper, refers to the type of planning known as "comprehensive planning," as contrasted with "project planning." While it is true that planning should precede the implementation of any project—whether it be

a building, a dam, or a drainage system — the planning I am going to talk about is the type of planning that is community-wide, and includes all kinds of physical development that occurs within a community, such as the use of land, the location of streets and highways, size and character of buildings, water lines, sewer lines, the location of drainage channels, and structures.

The major purpose of a comprehensive plan is to harmonize, coordinate, and adjust all physical development so that everything will be properly related to everything else in a community. That is, so that parks will not be constructed in the path of a highway, so that a narrow street will not be constructed where a wide thoroughfare will be needed, or so that the location of a tallow and hide works will not depreciate residential development.

In order that you may see how mosquito abatement fits into a comprehensive plan, I would like to say that there are two main features to a comprehensive plan. First is a plan of land use, showing what land is best suited for agriculture, residences, commerce, industry, grazing, and recreation. About 50 per cent of the developed land in an urban area is used for residential purposes, 3 per cent for commercial purposes, 5 to 10 per cent for industrial purposes, and 10 to 15 per cent for recreation and schools. To show what land is most appropriately suited for each is the purpose of a land-use plan.

I think it is obvious that the design of a street system best suited to serve residential land is much different from a system designed to serve industrial or recreational land. Likewise, a sewer system or water system designed to serve residential land is different from a system designed to serve other types of land uses. The same thing is true of a drainage system. While water flows downhill, its path is influenced by the use of land. In one type of land use, storm sewers may be necessary; while through others devoted to different uses of land, open natural channels may be called for.

The second feature of a comprehensive plan is a community facilities plan, which includes streets, water lines, sewers, parks, playgrounds, drainage channels — anything that has a physical position in the city and is used by the public. In other words, a land-use plan reflects how land should be used. A community facilities plan expresses the type and character of the facilities that are needed to serve the land and the people who live on the land.

Lack of a comprehensive plan has resulted in some strange things. Industries have been put in the midst of growing residential areas. Good agricultural land has been consumed for urban uses, while unproductive land lies vacant. Neighborhood parks have been developed only to be destroyed a few years later by major highways. State highway departments have been notorious for routing major streets through the center of residential areas, leaving disorganization and loss of residential amenities in their wake. The fact of the matter is, this has occurred so frequently that Congress in 1962 specified that no more Federal Aid Highway Funds would be available for highway construction in urban counties after 1965, unless a comprehensive highway plan has been adopted or is in the process of preparation. Similarly, urban renewal funds are not available any more until after a community has prepared a comprehensive plan. Right now the American Municipal Association is currently attempting to get Congress to require the preparation of a comprehensive plan before any type of federal aid can be extended to a community, including mortgage insurance, public works, ditch lining, land leveling, rural renewal, and other aids to urban development. This would also conceivably apply to any federal funds which might be available in urban areas for mosquito abatement projects.

I am not here to give you a course in city planning. However, in the process of preparing a comprehensive plan, five steps must be followed: (1) Goals and objectives must be formulated and agreed upon. (2) Surveys must be made and factual data collected. (3) The basic data must be analyzed and evaluated. (4) Alternative solutions must be considered and a plan prepared. (5) The plan must be implemented.

How many of you have had the experience of preparing a plan or a program, only to have it annihilated or severely emasculated by someone who disagreed with you, or who refused to budget necessary funds to carry out your plan? I am sure we have all been thwarted or frustrated sometime in our lives. Whenever this occurs, it points up the truth of a cardinal rule of comprehensive planning, which is: Planning in a democracy can proceed only after agreement on goals and policies has been reached.

A few years ago I worked on a plan to put all of the area along the east side of Utah Lake into a sanitary district. The idea was to locate sewage-treatment plants so that the eight major cities in the county, as well as the area between the eight cities, could be served by five treatment plants. Then as urbanization took place and the territory between the cities was developed, it would be a simple matter to extend sewer mains to connect with outfall lines which, in turn, would lead to the treatment plants. It was a good idea. It would have cost only two-thirds of what was finally worked out. As it is, each major city now has a treatment plant. Already Provo has had to install lift pumps in order to serve parts of her territory. Other communities will have to do the same as expansion takes place.

But the county-wide sanitary district failed. The plan and all the work that was put into it went down the drain, all because we overlooked the necessity of obtaining agreement on policies. Two people jumped on their white horses and charged up and down the county yelling "foul." They yelled so loud and long that the people concluded that where there is smoke there must be fire, and with that, they voted against the district and against their own self-interests — even after the major industry in the county had expressed a willingness to pick up the tab for at least one-fourth of the cost of the entire project.

I personally believe that the most effective way of getting the physical features of a mosquito abatement program accomplished — such as drainage channels dug, culverts constructed properly, and other mosquito-

breeding places eradicated — is to include mosquito abatement as a goal in our comprehensive planning program. Once this has been accomplished, progress can be made.

Utah County is now in the process of tooling-up to prepare a comprehensive plan for the county. I am going to do the best I can to include mosquito abatement as one of the goals. When the time comes for us to establish planning goals and policies for the county, I hope that those who are interested in mosquito abatement can help formulate this objective. If this can be done, then appropriations for mosquito abatement should not be difficult to obtain.

OWNERSHIP OF WATER RIGHTS AND RESPONSIBILITY FOR WATER USE

R. KEITH HIGGINSON
Utah State Engineer's Office

An understanding of the basic water laws of the state is essential to anyone working in a field in which the use or misuse of water affects the problems he must consider. Municipal officials responsible for the quality and quantity of city water supplies must know what a water right is, how it is obtained, and what must be done to protect it. One of the first considerations of the industrial engineer in studying a new plant proposal is a study of the location and year-to-year availability of the needed water supply. Farmers and ranchers throughout the state must be familiar not only with their own rights, but also those of their neighbors in order to properly evaluate anticipated supplies and plan seasonal operations. Recreation officials at our lakes and wildlife refuges must know the quantities of water which may be expected during any period to plan fish planting, boating, waterfowl and other water-connected programs. All users must know what the existing rights and needs of all other users are from the sources affecting their right.

Although I know little about methods of mosquito control, I feel sure that an understanding of the basic water laws could be helpful to you in your work. For this reason I am happy to present some thoughts which you may find useful.

To be able to discuss water rights, we must first adopt a common definition. I suppose that in the past there have been almost as many definitions as water users. Each would like to define his water right as it relates to his own individual use, his past practice, and future need.

A certain Grantsville farmer may be convinced his rights entitle him to allow his wells to flow without control, winter and summer, rain or shine. To him the large quantities wasted are unimportant and are in fact necessary so long as a small quantity is beneficially used.

A group of Milford farmers feel they should be entitled to divert as much as 10 acre-feet of water per acre onto their land from wells if they desire it because that is the amount they formerly applied when there was little agricultural development in the area and no restriction on pumping.

Canal companies near some of our major metropolitan areas claim they are entitled to divert from the source the same quantities as formerly, even though many hundreds of acres within their service area have become subdivided with a marked reduction in the need for water.

A "gentleman" farmer near Cedar City has only a small acreage and makes his basic living in industry. In his mind, his water right allows him to set his irrigation stream in the morning and go off to work and allow it to run untended all day.

Residents of the low-lying areas in the southern part of Utah County obtain domestic water supplies from small flowing wells. They are contending that their rights require that pressures be held at a high level even though this will maintain large areas of marshland and will prevent development and more beneficial use of the ground water resources of the area.

After considering these "local" definitions I believe we can see that a water right must be considered in relation to all other uses of water within the same general area. We cannot permit water, which is a public resource, to be tied up by some people for limited beneficial use to the detriment of full development. Therefore, I would define a water right as: *A title to the use of part of the public water resource for a beneficial purpose limited by considerations of the public interest.*

A brief discussion of the process of determining water rights may be appropriate at this time. First let me point out that there are three basic types of rights recognized in the State of Utah:

A. Diligence right — surface water — before 1903
ground water — before 1935

B. Appropriation right — surface water — after 1903
ground water — after 1935

C. Adverse-use right — seven years before 1939.

There may be other types which involve federal and Indian claims, but I will not touch on them here.

All of those listed in the "B" category will be on record in the state engineer's office. However, except for those contained in the various river decrees of the state, only a small part of the others will be recorded with us. It is the purpose of our Adjudication Division to assemble, analyze, and prepare determinations of rights within the state on an area-by-area basis. As most of you no doubt understand, this is a long and involved legal process before the district court. Its purpose is to put to rest disputes between users and to impose limitations of beneficial use and public interest on all rights of an area.

Following the formal filing of petitions by water users and the issuing of a court order, field surveys of an entire drainage area are made, generally using aerial photos as a base. Records of the county are searched to obtain property ownerships and any past court decrees affecting water rights. Claims to the use of water are prepared, signed by the water users, and

the claims are tabulated and examined. The state engineer then prepares a "Proposed Determination of Water Rights" (proposed decree) which is served upon all water users. This proposed determination contains recommendations on such matters as length of irrigation season, diversion (flow) rates, and seasonal water allowances for domestic use, stock watering, irrigation and other uses. The court hears any protests to the proposed determination, rules on the protests, and then issues an order adopting the final determination as a decree.

At the present time we are actively engaged in preparing determinations of rights on the areas indicated on the map. The horizontal-lined areas have had determinations published while in the vertical-lined areas, work is in progress.

The next step required following the adjudication of water rights is distribution or state administration of the use of water. Commissioners are appointed to regulate diversions and to see that the decree is followed. At the present time we have 26 river systems or ground water basins in the state under regulation. Many of these systems are based on outdated court decrees which will be modified as new determinations covering those areas are prepared.

We feel that the work accomplished under these programs so far has been of benefit to the people of the state. In many cases the completion of determination and regulation of the use of water under it has eliminated wasteful practices and actually made a firm water supply available to users with late priorities who formerly received very little water.

In the Escalante Valley area of southwest Utah, which is largely irrigated from pumped wells, the court has imposed limitations of 4 acre-feet of water per acre on agriculture. Although research studies show that the crops grown there can actually consume only 2 to 3 acre-feet per acre, records show that formerly some farmers at Milford applied as much as 10 acre-feet per acre with resulting waste of water and power. Meters have now been installed on each well and commissioners control the pumping in the area. Similar control will be placed on other ground water basins as the need arises and as we can complete the program.

Surface water users who have operated under old court decrees for many years often find that their rights have been redefined by the adjudication using considerations of present-day public interest, beneficial use, presently irrigated acreage, canal seepage loss computations, etc. Such appraisal should aid immeasurably in those areas where urban development has taken many acres out of agriculture but with the same total amounts of water available to the remaining users.

It is hoped that in future months the courts or the Legislature will more clearly define the rights of well owners to a particular water level or pressure. Unless something is done to change the legal precedents and to alter present-day public thinking, ground water development will stop in certain areas, but heavy waste of the resource will continue.

As a final consideration I would like to quote from the Utah Code with regard to the state engineer's authority over waste of water:

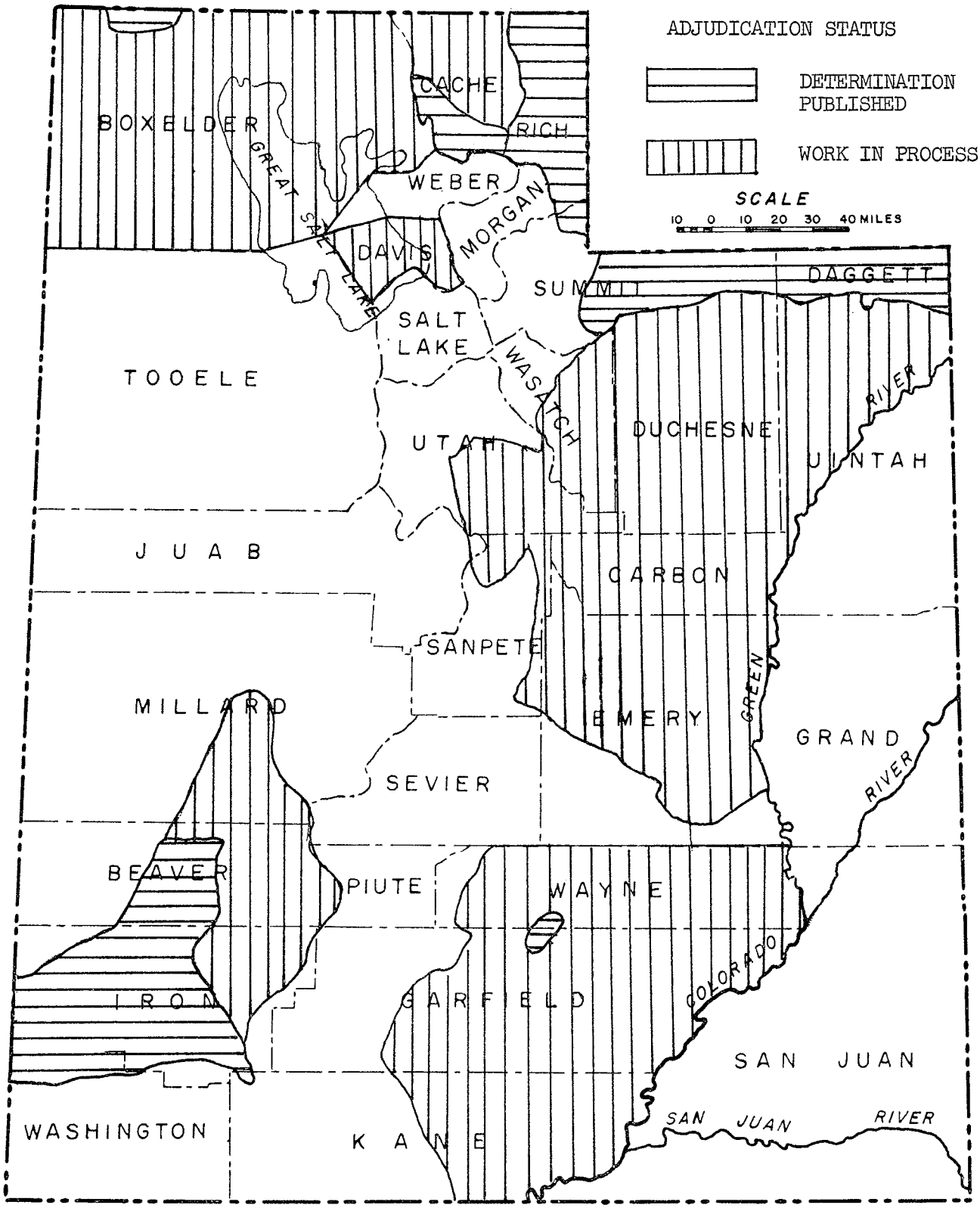
> To prevent waste, loss, pollution or contamination of any waters whether above or below the ground, the state engineer may require the repair or construction of head gates or other devices on ditches or canals, and the repair or installation of caps, valves or casings on any well or tunnel or the plugging or filling thereof to accomplish the purposes of this section.
>
> Any requirement made by the state engineer in accordance with this section shall be executed by and at the cost and expense of the owner, lessee or person having control of such diverting works affected. If within 10 days after notice of such requirement as provided in this section, the owner, lessee or person having control of the water affected, has not commenced to carry out such requirement, or if he has commenced to comply therewith but shall not thereafter proceed diligently to complete the work, the state engineer may forbid the use of water from such source until the user thereof shall comply with such requirement. Failure to comply with any requirement made by the state engineer in accordance with the provisions of this section shall constitute a misdemeanor. Each day that such violation is permitted to continue shall constitute a separate offense. (Section 73-5-9, Utah Code Annotated, 1953).

When violations of this section are brought to our attention, steps are taken to require the necessary control or repair work insofar as possible. As you are well aware this is often a difficult thing to enforce. Just passing a law does not necessarily mean that it can be enforced unless the public is educated to its desirability and unless they understand that it is in the best public interest to follow it. Often times, waste of water may be adverse to what your association is striving to do, namely combat the production of mosquitoes. Here is an opportunity for us to work together and eliminate waste of water because it creates a nuisance. We need your help and backing and are most anxious to work with you. I believe that many mosquito-producing areas can be eliminated if we can invoke the basic principle of water rights — beneficial use. You must point your finger at the problem, and studies such as Dr. Rees has under way will help you to know where to point. The cooperative study of water resources in Salt Lake County under the leadership of the U.S. Geological Survey will also help. Let us direct these and other studies toward getting the kinds of data needed to answer these important questions and then use the data to the benefit of our bosses — the public. It should be remembered that no one owns water in Utah, we only own rights to its use. Continued enjoyment of that right is based on our ability to use the water efficiently and without waste.

WATER RESOURCE STUDY IN SALT LAKE COUNTY

W. V. Iorns, *Hydrologist*
United States Geological Survey

In December 1961, the state engineer for Utah called a meeting of water users and those interested in, and responsible for, water resource development in Salt Lake County. The purpose of the meeting was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SAN JUAN RIVER

to discuss the immediate and future water problems facing the people of Salt Lake County and to consider means of meeting them.

Salt Lake County and the surrounding area, as you are probably aware, are generally blessed with a fairly abundant supply of relatively good quality water. However, the population explosion and rapid industrial development of the recent and near-future years may tax, even exceed, this abundant supply.

At the present, public and rural domestic use of water in the county is about 77,000 acre-feet annually; industrial use, about 117,000 acre-feet annually; and irrigation use, about 300,000 acre-feet annually. It is probable that by 1975, if the population in the county increases a projected 300,000 together with an accompanying increase in industry, as much as 150,000 to 200,000 acre-feet may be required for public and rural domestic supplies, and a like amount for industry. The indicated requirement of these uses may, therefore, approach 150,000 to 200,000 acre-feet of additional water. Irrigation use of water is not expected to increase but may be somewhat reduced because of changes from agricultural lands to urban developments. A major part of this additional water will have to be of good quality, but some of the industrial water can be of relatively poor quality.

Where will this additional water be obtained? Some of it may come from the surface streams draining the Wasatch Front; any appreciable amount from this source will, however, require the construction of storage reservoirs. Some may come from ground water, and some from importation of water from sources outside the county.

A major surface-water-storage development in the county is presently under consideration and plans are being formulated for importation of water from the Colorado River Basin. A recently completed study indicates that there is a large potential for development of additional supplies from the ground water reservoir underlying the Jordan Valley. However, until factual information, on how much water, of what quality, and at what cost, is available from the different sources, there is no basis for wise decisions on which source of supply should be chosen or in what order the different sources should be developed. Full development of the supply available in the boundaries of the county may be more economical than importing water from outside sources, and may also be in the best interest of complete water resource planning and development for the state.

Those responsible for water management, to make sound decisions regarding water development, use, control, treatment, conservation and law, must have as complete information as possible of the behavior and characteristics of the surface and ground waters of the county. The following questions illustrate the information needed:

1. How much water is available from local sources for use now and in the future? Is the available water suitable for the varied uses, or must extensive treatment be employed for some uses?

2. What part of the available ground water supply has been developed? Has development caused the quality of the water to deteriorate?

3. Is artificial recharge a possible solution to the problem of declining ground water levels? If so, where and how might artificial recharge be accomplished? How much water might be stored for future use by this means? Will its suitability for use be greater or less than surface water supplies? Should lands for recharge areas be zoned at an early date?

4. How much water is being discharged into Great Salt Lake? Can part of this water be salvaged for use? Is it suitable for municipal, industrial, agricultural, recreational, or wildlife use?

5. Will further development of ground water resources cause intrusion of brine from the lake? Can manipulation of discharges of water from wells deter possible intrusion?

6. How much water can be stored at different potential storage sites in the county?

7. Have changes in land use caused changes in runoff, sediment production, or water quality?

8. How serious are flood threats along the various watercourses? With what frequency and magnitude may floods be expected?

9. Should some drainage channels and floodplains be zoned for restricted use?

10. How much water, if any, will need to be imported from outside sources to meet future demands?

To provide this information, an investigation of the water resources of Salt Lake County was undertaken by the Water Resources Division of the U.S. Geological Survey in July 1963. This is a cooperative project financed equally by the State of Utah and the federal government in accordance with a cooperative agreement between the state engineer and the Geological Survey. The Utah Water and Power Board, Utah Fish and Game Commission, Salt Lake County Water Conservancy District, Metropolitan Water District of Salt Lake City, Salt Lake County, Kennecott Copper Corporation, Utah Power and Light Company, and Salt Lake Chamber of Commerce are contributing funds to the office of the state engineer toward the support of the project, which is planned to last about six years — the first five years will be principally for data collection and data analysis and the last year for report preparation.

The study will encompass the collection and interpretation of a wide variety of hydrologic data, for example, data will be collected on precipitation, temperature, evaporation, consumptive use of water by native and cultivated vegetation, infiltration rates of soils and exposed rock surfaces, flow of streams and canals and their chemical character, and the occurrence of ground water, its movement, and chemical character. Facts collected will be only that which is necessary to implement existing data-collection programs. Maximum use will be made of hydrologic information collected by others. From analysis of these and other related data, the movement of water over and through the earth — from the time it occurs on the surface as precipitation, or enters the county in the Jordan River and the Provo River Canal, to its final deposition to the atmosphere or to the Great Salt Lake — will be traced, so far as possible.

I believe that many of the results of the investigation will be useful to those responsible for mosquito control in the county. Data will be available on the

flows and chemical character of the streams. For the first time, gauging stations will be in operation on streams entering the major mosquito-producing areas. Data provided by these stations can be useful in day-to-day mosquito control operations.

We in the Geological Survey — particularly those who are actively engaged on this project — wish to cooperate in every way possible with this association and its operating personnel in controlling mosquitoes. We can well do without the pesky, biting "buggers."

MOSQUITO CONTROL IN UTAH COUNTY

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Provo, Utah

The year 1963 noted the beginning of mosquito control in Utah County. It was a modest beginning but a significant one, for the program will be in operation again in 1964.

While the *Aedes dorsalis* population explosion of June 1963 caused many problems throughout northern Utah, it was the stimulus needed to initiate control activities in Utah County. There was considerable public feeling supporting mosquito control and petitions were presented to the County Commission urging the establishment of a control program under the direction of the Department of Health. However, each petition specifically opposed the formation of an autonomous mosquito abatement district even though an informational ballot had been passed in the 1962 election. The health department was not aware of the petitions prior to their presentation to the Commission.

At the request of the Utah County Commission, appointments were made by the health department to visit the Salt Lake City and Weber County Mosquito Abatement Districts. The purpose of these visits was to allow the commissioners to observe abatement operations. At the conclusion of this tour a budget was requested for the remainder of the control year.

A budget was submitted requesting $35,300 to cover the total operation and acquire equipment and vehicles. Of this amount, $20,000 was allotted with the stipulation that two pickup trucks would be provided and maintained by the Utah County Road Department. Mileage was paid to those individuals using their own vehicles in the field.

The control operations were similar to those employed elsewhere. Due to the lack of suitable vehicles, emphasis was placed on hand application of insecticides. The most useful device for this purpose was the "Skeeter Bater" granule applicator. One per cent parathion sand core granules were used almost exclusively. The sand core granule is preferred for use in the "Skeeter Bater."

Only three insecticides were used during the control period. These were Baytex, parathion, and DDT. Baytex and parathion were used primarily in pastures and DDT in areas where residues would be no problem. Eight-pound parathion in fuel oil was applied by air at a rate of 0.1 pound per acre. Baytex was used in power and hand sprayers at a rate of 0.1 pound per acre.

Public acceptance of control efforts was good. Information regarding program operations and limitations was released through all media of communications.

Population indices based on light trap collections were substantially lower when compared with the same periods in 1961 and 1962. Control activities were begun the first of August and carried through September.

The prospects for 1964 must be approached with some anxiety. A budget request of $62,584 was submitted to the County Commission for 1964 and of this amount $32,815 was allowed. This means that, once again, control efforts will be greatly restricted and the effectiveness reduced. The same limited work force of August and September must now cope with the problems and mosquito populations which accompany spring runoff and extensive early irrigation.

There is also no assurance at this time that the program will be left under the direction of the City-County Department of Health. If it is not, it will then become another department of county government.

PROBLEMS OF INSECT RESIDUES

GEORGE F. KNOWLTON, *Entomologist*
Utah State University
Logan, Utah

During the past few years, increasing federal, state, and public attention has been focused on pesticides and their uses. For this reason, and the improved accuracy for determining minute quantities of insecticides in or on products, we must look with particular care at each of our operations.

Pesticides applied to pastures, forage, and food crops must all be considered from the standpoint of public policy. We cannot set up one set of rules and restrictions for the farmer, the livestock grower and orchardist, and exclude groups who serve the public with equal responsibility. We are interested in larvicides for the 1964 control season and should particularly think this through with care. We must see to it that DDT, dieldrin, heptachlor, or similar chlorinated hydrocarbon insecticides are not being applied where they will contaminate alfalfa or other hay crops which will be fed to milk cows. The same principle applies wherein we must not contaminate pastures grazed by dairy cows. This particular group of pesticides has created many problems where alfalfa and other crops are concerned.

This past season, two Utah cheese plants closed when it was found that dieldrin was present in some of the cheese being processed. Thousands of dollars in loss was experienced even by the milk producers whose product later proved on chemical analysis to be non-contaminated. Considerable time was required for chemical testing which permitted the plants to resume operations using only the milk which was found to be free from contamination with pesticides. The U.S. Food and Drug Administration has set up a "zero

tolerance" for pesticides in milk. They have analytical methods which will now accurately show amounts of some of these pesticides down to about one part per billion. It requires only a little DDT, dieldrin, aldrin, heptachlor, or lindane on feed or stored in the fat of dairy cows to have the pesticide appear in the fat of the milk. It is our responsibility to police our own operations to maintain the established public policy with regard to chemicals we apply in agricultural areas. We must remain aware of the effect of our control operations on the entire environment, and not just as it affects the degree of mosquito control we achieve at the lowest cost for chemicals and labor.

In January 1964, the U.S. Department of Agriculture withdrew its registration for heptachlor in the West for very early spring spray application to control adult alfalfa weevils. For years the standard control had been 4 ounces of either actual heptachlor or dieldrin per acre, applied before first spring growth exceeded 2 inches in height. Finding that some alfalfa treated in this manner had heptachlor or heptachlor epoxide contamination, the federal agency withdrew this heptachlor registration. In recent years the general tendency in mosquito control and pest control on forage and food crops has been moving away from so much use of chlorinated hydrocarbon insecticides because of the residues they leave on crops, and has been moving to more extensive use of the phosphates and some carbamate insecticides.

The residues usually looked for in the analysis of feeds and food crops include DDT, DDD, lindane, BHC, toxaphene, chlordane, heptachlor, perthane, dieldrin, endrin, and methoxychlor. It is this group of pesticides which is being watched most closely by federal and state chemists and health officers.

Cows and heifers grazing on pastures, or fed forage contaminated with DDT, dieldrin, or some of the other pesticides in this group, may require from several weeks to six months or longer on uncontaminated feed before their milk is acceptable to a dairy. Cows being milked lose the pesticide from their bodies more rapidly than do the dry stock. The length of time needed to "clean up" a herd depends to a major extent on the level of pesticide already present in the body fat when the herd was put on uncontaminated feed.

Some mosquito control is needed in areas where sugar beets are grown, and sometimes near alfalfa, corn, and pea fields. Spraying over or drifting DDT and related pesticides on these crops will result in pesticide appearance in the milk if the contaminated beet tops, pea vines, corn, or alfalfa are fed to milk cows.

In Utah, as elsewhere, organized mosquito control programs have moved in the direction of using less DDT and related chemicals during recent years. This trend is getting us away from our number-one residue problem — possible contamination of livestock forage and feed.

If any districts are still using a substantial amount of DDT and related chlorinated hydrocarbons, I strongly urge a careful rechecking of areas where these are to be applied. As representatives of the public, we cannot justify the use of chemicals on crops and pastures which leave a residue possibly resulting in loss of income to the property owners due to our operations. We may find ourselves legally liable for any financial losses caused by ill-advised control programs.

UTAH MOSQUITOES — THEIR PUBLISHED HISTORY: SUPPLEMENT I[1]

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University of Utah

This report is the first supplement to the paper by Linam and Nielsen which appeared in the 1963 Proceedings of the Utah Mosquito Abatement Association. It contains references to Utah mosquitoes that have appeared since the previous report was published and also includes several papers that were previously overlooked in the preparation of the first manuscript.

Abbreviations used are: AMCA (American Mosquito Control Association), CMCA (California Mosquito Control Association), NJMA (New Jersey Mosquito Extermination Association), UAS (Utah Academy of Sciences, Arts, and Letters), UMAA (Utah Mosquito Abatement Association).

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UNPUBLISHED THESIS — UNIVERSITY OF UTAH

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GAMBUSIA FISH FOR RICE FIELD MOSQUITO CONTROL IN CALIFORNIA

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Yolo County Mosquito Abatement District
Sacramento, California

We in mosquito control in California have benefitted in the past by the use of the fish *Gambusia affinis* in rice fields as a natural control of mosquitoes.

Our present aim is to control mosquito breeding in rice fields using only mosquito-fish. This year we greatly expanded this control method. Our only limitation was the number of fish available for planting. We believe this is the most desirable method for control of mosquitoes in rice culture. This past year approximately 35 per cent of our rice fields were planted with an estimated total of 1,257,300 Gambusia fish. This program in a more limited manner has been carried on since 1957 by our district.

There are several important desirable factors influencing the use of fish in rice fields for the control of mosquitoes:

1. Substantial reduction or the elimination of chemical sprays.

2. The cost is much less than repeated chemical treatments.

3. Better control — less mosquito production than is realized by present practices using chemical control.

In our complex man-and-animal environment the elimination or substantial reduction of the use of chemical insecticides is desirable and of great importance. In the hot rice-growing regions, a tremendous adult mosquito population usually builds up. Larval counts can increase rapidly necessitating repeated larvicide treatments. In our district we have sprayed many rice fields five times or more in one season. When a rice field is checked and the larval count justifies that the field be larvacided, there are, at that time, four stages of the mosquito present.

Our experience has shown that, in fields properly planted with Gambusia fish, normally no build-up of insects develops. For example, in 1963, of 83 rice fields planted with Gambusia, only five averaged as much as one-half larvae per dip during the long rice-growing season. May I note here that, although mosquito larvae were found in some of our fish-planted fields, pupae were very rarely seen. This low count of one-half larvae per dip developed once in four of the fields and twice in the fifth field.

To achieve success by using mosquito-fish in rice fields, two important factors should be considered: (1) elimination of bad mosquito sources adjacent to the rice field — this includes good rice farming practices by the grower and proper disposal of waste water; and (2) the proper handling and planting of the Gambusia fish. This covers many things and may raise the question of what is meant by proper handling and planting. This may be explained as the methods and techniques we have found by experience to be the best to assure that maximum numbers of active fish are present by the time the rice plant emerges above the surface of the water.

Some procedures are listed in order of time: adequate feeding of fish in the winter holding ponds, good fish recovery areas in ponds, and proper seine sizes to collect only adult fish. For example, 200 planted mature Gambusia will result in 4,000–8,000 fish within a 30-day (or less) period. Proper and quick transporting of collected fish, proper distribution in the rice field, and limited feeding of planted fish for a period in some situations cannot be overemphasized.

In a large fish-planting program there should be a salvaging program in the fall of the year to restock the winter holding ponds. Again, certain methods should be followed to be efficient and to avoid failure. For example, use of proper collection nets and minnow traps, selection of best collection areas, and methods of separating Gambusia from coarse or game fish, if they are present before restocking the winter holding ponds, are key factors.

The items briefly touched on above are each important and may, if not properly exercised, mean an ultimate failure in a fish-planted rice field.

At the present time we are planting Gambusia fish in temporary rain pools, drains, and any other water that creates early mosquito sources in the spring of the year. Roadside ditches are planted as soon as there is water, as well as temporary streams that would have to be hand sprayed every ten days if fish were not planted there. In some instances, these same areas serve as stock pools to provide Gambusia for our rice field program.

NEW DEVELOPMENTS IN MOSQUITO CONTROL

DON G. DENNING
Chemagro Corporation

Almost all insecticides that are now used in mosquito control were developed for agricultural uses. In the current research, agricultural chemicals are the prime source for new compounds being tested for new mosquito control pesticides.

The agricultural chemical industry and entomologists are continuing their search for more effective and safer pesticides. The cost of developing a successful new insecticide has increased tremendously — from about $1 million a few years ago to nearly $3 million now, and the cost will become higher as the present high standard of final acceptance of a new insecticide is maintained.

A use pattern away from chlorinated hydrocarbon insecticides in mosquito control commenced several years ago and this trend will be accelerated. The replacement has largely been with the organic phosphate insecticides — just as in the control of agricultural pests. Chemical control is in many instances selective: there is an association here between species and their ecological niche, and therefore it can be expected that eventually many of the pest mosquitoes will become resistant to the phosphates in both the larval and adult stages. Chemagro Corporation is continuing to research phosphate derivatives for mosquito control and is also researching a new chemical-insecticide family, the carbamates, for mosquito adult and larvae control.

Very little research work is in progress with Bayer 41831, or Folithion. The chances for development of this product for mosquito control are remote, since already in a California phosphate-resistant area tests did not give adequate kill to *Aedes nigromaculis* larvae. Lewallen (1963) reported on 1960–61 field tests of the product against nonresistant *Aedes nigromaculis* and *Anopheles freeborni* larvae in which he obtained 99 to 100 per cent control at 0.3 pounds per acre. Mulla (1963) reported rapid disappearance of Bayer 41831 from water. When this chemical was applied at the rate of 0.8 pounds per acre, 68 per cent disappeared after 24 hours.

Mosquito control researchers have reported on Bayer 25141 because this phenyl phosphorothioate is about equal to Parathion in larval control: 0.1 pound per acre gave 100 per cent kill to *Culex tarsalis* larvae. Water persistence is long; 2 ppm in water remained at 2 ppm after 96 hours and *Culex p. quinquefasciatus* mortality remained at 100 per cent. It is reported that 1.8 pounds per acre is nontoxic to Gambusia. However, in a California phosphate-resistant area Bayer 25141

was tested and gave poor results. It is probable that the material will not be developed for mosquito control.

Our Bayer 37289, an ethylphosphonothioate product, has been screened against *Culex tarsalis* late instar larvae; at 0.05 pound per acre the control was 100 per cent. Persistence in water is not long — 82 per cent of an 0.8-pound-per-acre rate had disappeared after 72 hours. The product is apparently safe to Gambusia at 0.4 pounds per acre. We are currently not planning on developing this material for mosquito control.

The carbamate Bayer 37344 has created considerable interest and mosquito control researchers Mulla *et al.* (1962) established an LD_{50} to *Culex p. quinquefasciatus* larvae at 0.18 ppm. Papers by Mathis and Schoof (1963) and Jakob and Schoof (1963) have established the very long residual activity against adults. In their tests on DDT and/or Dieldrin-resistant *Anopheles quadrimaculatus, A. albimanus,* and *Aedes aegypti* adults, Bayer 37344 at 200 mg per square foot displayed the greatest potential giving 48 weeks of kills above 70 per cent. Smith (1963) recently wrote that in the assessment of insecticides as adulticides the "excito-repellent effects" should be considered; that is, the insecticide effect on behavior should be assessed in determining the residual toxicity. Smith used Bayer 37344 to determine this factor in a three-month test period on *Anopheles gambiae* adults. The product had a repellent action, but its action was effectively non-repellent because its rapid toxicity acted as a counterweight. Smith concluded Bayer 37344 is a rapidly toxic material, with repellent properties of no practical significance; it has a residual toxicity of about three months.

Bayer 39007 is another carbamate which possesses long-term residual action against adults. After four weeks, 100 mg per square foot gave 70 per cent kill of *Anopheles quadrimaculatus*; after two weeks 70 per cent kill occurred to *Aedes aegypti.*

In his papers on carbamates, Smith mentioned that mosquito control researchers should keep in mind that these compounds exhibit greater species specificity than the OP compounds, and degradation by alkaline media may also be more rapid.

New information on BAYTEX is that it is persistent in water; 2 ppm had degraded only to 1.87 ppm in 96 hours. Toxicity to large trout, its effect on fish eggs and sperm, on hatch and fry, is very favorable.

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MOSQUITOES AS ACTUAL AND POTENTIAL VECTORS OF DISEASE AS NOW KNOWN FOR UTAH

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Although a dozen or more diseases of man and other animals are known to be transmitted by mosquitoes, encephalitis is the only one of importance in Utah. Records of the U.S. Department of Agriculture show that equine encephalitis cases occurred in Utah during 16 years of the 17-year period, 1939 through 1955. During ten years of this period, several counties reported five or more cases of encephalitis per 1,000 horses, which is considered a high incidence of the disease among equines. In 1941, 21 of the 29 counties in the state reported an incidence of the disease in excess of five cases per 1,000 horses. The largest outbreak of human encephalitis in Utah occurred in 1958 when 48 cases were confirmed by laboratory procedures (Jenkins and Donath, 1959).

Thirteen of the 40 species reported in Utah, including five species of *Culex,* four of *Aedes,* two of *Culiseta,* one of *Anopheles,* and one of *Mansonia,* have been found naturally infected with one or more of the arboviruses or are proven experimental vectors. These are listed in Table I (p. 26) with the bibliographic reference number referring to published records of natural infection or proven experimental transmission of virus. With respect to western equine encephalitis (WEE), Hess and Holden (1958) state that *Culex tarsalis* is unquestionably the primary vector in both the sylvan and endemic transmission cycles in the western United States. In Utah, *C. tarsalis* appears to meet the criteria for determining a primary vector of this disease. This mosquito occurs abundantly throughout the state at elevations below 7,000 feet, and smaller populations have been found at elevations up to 9,500 feet. Investigations by the Disease Ecology Section, Communicable Disease Center, U.S. Public Health Service in 1963, showed that *C. tarsalis* feeds on a wide range of avian hosts of encephalitis virus including passerine and upland game birds, waterfowl, chickens, and hawks, as well as a variety of mammals including horses, cattle, dogs, cats, rabbits, and small rodents. The fact that *C. tarsalis* feeds readily on humans is well documented. WEE virus has been isolated from *C. tarsalis* collected in several areas of Utah, and both WEE and St. Louis encephalitis (SLE) viruses have been isolated from naturally infected *C. tarsalis* in other parts of the western United States. The known vectoring potential of *C. tarsalis,* its abundance over much of the state, and

[1] From the Disease Ecology Section, Technology Branch, Communicable Disease Center, Public Health Service, U.S. Department of Health, Education and Welfare, Greeley, Colorado.

its close association with avian reservoirs of virus and other susceptible hosts, including man, implicate it as the primary vector of encephalitis virus in Utah.

Culex pipiens is widely distributed in Utah, but sizable numbers have been found only in the vicinity of urban areas where propagation of the species usually is associated with inadequate sewage systems, improper disposal of cannery wastes, and water-holding receptacles. On the basis of studies during the past decade, there is reason to believe that *C. pipiens* has become more prevalent in Utah during recent years, particularly in areas where facilities for proper disposal of sewage and other wastes have not kept pace with urbanization and industrial development. Larval collections taken during the encephalitis outbreak in northern Utah in 1958 showed *C. pipiens* to be the predominant species in Box Elder and Weber counties, and second only to *C. tarsalis* in Davis County. During the same period large numbers af adult *C. pipiens* were observed in the vicinity of favorable breeding places, but rarely was a female taken in biting collections. The apparent reluctance of *C. pipiens* to feed on man is further substantiated by host preference studies conducted by the Disease Ecology Section, CDC, U.S. Public Health Service, at Greeley, Colorado, during the summer of 1963. Of approximately 400 *C. pipiens* tested, 95 per cent were positive for various avian hosts; and 5 per cent were positive for mammals including cattle, horses, dogs, cats, pigs, and rabbits. Only one specimen had fed on man. Because of its restricted feeding contact with man, *C. pipiens* probably is of little significance in the endemic transmission cycle of encephalitis. However, the demonstrated preference of this species for avian hosts suggests that it may be an important enzootic vector of arbovirus from one wild host or reservoir to another.

The three additional species of *Culex* recorded in Utah, which have been found naturally infected with arbovirus, are of rare occurrence; and their collection anywhere in the state is primarily of academic interest. In Utah these species — *Culex quinquefasciatus, Culex restuans,* and *Culex salinarius* — apparently never reach the population threshold required for effective transmission of virus.

A few isolations of arbovirus have been made from wild-caught *Culiseta inornata.* This species and *Culiseta incidens* are proven experimental vectors of WEE and SLE viruses. Cache Valley virus, a member of the newly designated Bunyamwera group of arboviruses, was first isolated from *C. inornata* collected near Wellsville, Cache County, Utah, in 1956 (Holden and Hess, 1959). The relationship of Cache Valley virus to the health of humans and other animals is not known, but it has been found that the virus is neutralized by sera obtained from horses living in the area from which the mosquitoes were collected. Precipitin studies on *C. inornata* and *C. incidens* collected during the summer of 1963 in Colorado have shown that both species feed almost exclusively on mammals. Of more than 900 female *C. inornata* tested, over 98 per cent had fed on cattle and horses, about 1 per cent on other mammals including pigs, rabbits, dogs, and small rodents, and less than 0.5 per cent on birds. All of the *C. incidens* tested had fed only on mammals such as cattle, horses, and rabbits. On the basis of these precipitin tests it appears that both *C. inornata* and *C. incidens* are of secondary importance with regard to viruses having a basic bird-mosquito-bird transmission cycle. However, they may be important for any viruses having a wild-mammal-reservoir host.

The comments regarding relationship of the two species of *Culiseta* to the transmission of virus apply similarly to four species of *Aedes,* which occur in Utah and have been found naturally infected with WEE virus. Precipitin testing of approximately 1,000 female *Aedes,* comprising *A. vexans, A. dorsalis, A. melanimon,* and *A. nigromaculis* collected during 1963, showed that over 98 per cent had fed on mammals of which cattle and horses were predominant with smaller numbers of rabbits and humans. Only two of these mosquitoes, both *A. vexans,* had fed on birds. Although these *Aedes* rarely feed on the avian reservoirs of encephalitis virus, their hosts include horses, rabbits, and various small rodents that have been found naturally infected with virus. The *Aedes* may be of considerable significance in the basic transmission cycle in nature, particularly during epizootics.

Mansonia perturbans has been found naturally infected with virus of eastern equine encephalitis in Georgia. It has not been found infected with WEE or SLE viruses, and its ability to transmit these viruses under experimental conditions has not been fully determined. Because of its restricted larval habitat, *M. perturbans* is of localized occurrence; and regardless of its vectoring capabilities is probably of little or no significance as a vector of arboviruses in Utah.

More than 30 different arboviruses have been isolated from over 20 species of *Anopheles* (Chamberlain, 1963). A number of these viruses are known to cause

TABLE I

SPECIES OF MOSQUITOES OCCURRING IN UTAH THAT HAVE BEEN FOUND NATURALLY INFECTED WITH ARBOVIRUSES OR ARE PROVEN EXPERIMENTAL VECTORS OF VIRUS

	Found naturally infected			*Proven experimental vector*		
Species	*WEE*	*SLE*	*Other*	*WEE*	*SLE*	*Other*
Aedes dorsalis	8*	8	8	17	–	–
A. melanimon	12	12	10	12	12	12
A. nigromaculis	13	–	–	17	6	–
A. vexans	14	–	–	7	7	16
Anopheles freeborni	11	–	–	–	–	–
Culex pipiens	11	11	–	–	11	–
C. quinquefasciatus	15	12	–	–	12	–
C. restuans	19	–	–	–	–	–
C. salinarius	–	–	20	–	–	–
C. tarsalis	5	5	10	6	7	–
Culiseta incidens	–	–	–	6	6	–
C. inornata	11	–	3	11	6	–
Mansonia perturbans	–	–	18	–	–	–

* Numbers in the table denote the following published bibliographic references to natural infection or experimental transmission of virus.

human disease. Over 100 isolations of Tensaw virus have been made from *Anopheles crucians* and *Anopheles quadrimaculatus* in the Southeastern United States. It is of interest to note that Tensaw virus, a member of the Bunyamwera group, is closely related to Cache Valley virus. Little or no work has been done to assess the importance of anophelines as vectors of arboviruses in Utah. Because of the prevalence of *Anopheles freeborni* in Utah, it is believed that investigations to determine the role of these mosquitoes in the natural history of arboviruses is warranted.

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RECENT ACCOMPLISHMENTS IN THE COOPERATIVE MULTIPURPOSE WATER MANAGEMENT IN UTAH[1]

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Since September 1, 1961, an investigation has been in progress to determine the effects of the use of water which eventually flows into the Great Salt Lake, upon mosquito production, waterfowl propagation and management, agriculture, and other operations dependent upon the use of this water.

At the 15th annual meetings of the Utah Mosquito Abatement Association held in March 1962, Dr. Don M. Rees, project leader, presented the objectives and the proposed research plan of this investigation (Rees, 1962). At the 16th annual meetings of the Utah Mosquito Abatement Association held in March 1963, Dr. Rees, Frank D. Arnold and Dean M. Andersen reported on different phases of the results of the first year of operation of this program (Rees, 1963), (Arnold, 1963), (Andersen and Rees, 1963). In addition, an annual report covering the first year of this project was released in May 1963 (Rees, *et al.*, 1963).

This work is being conducted in three study areas. In two of these areas, the Lake Front Gun, Fur and Reclamation Club and the Farmington Bay Waterfowl Management Area, the work has been in progress since 1962. The third area, the Wheeler Machinery Company Test Area, was included in the study during the latter part of 1962 but routine weekly inspection and sampling of mosquitoes and wildlife on this property were not conducted until 1963. The first two study areas are concerned with water management as it pertains to recreation and wildlife, primarily waterfowl, and do not provide an opportunity to study this water when applied to other beneficial uses. The land and water development included as a part of the program on the Wheeler Test Area provides an ideal situation for developing, field testing, and demonstrating facilities and techniques for multipurpose use of this water for wildlife and agriculture as primary objectives, with mosquito suppression and other public health aspects included in the development plans.

In addition to the collaborators participating in this program in 1962, Mr. M. T. Wilson, District Engineer, Water Resources Division, Geological Survey, and Mr. Eugene L. Peck, Chief, Hydrology Section, Weather Bureau, joined in 1963 as collaborators representing these agencies. All of the collaborating agencies have actively participated in the planning, development, testing, and other research activities of the program.

The number of sampling stations that were inspected weekly in 1962 was reduced in 1963 on the Lake Front Club and on Farmington Bay. This made it possible to add and sample weekly the 16 stations on the Wheeler study area. Larval and adult mosquito sampling was conducted in a manner similar to the methods used in 1962.

In 1963 increased emphasis was placed on wildlife studies. Nesting surveys of waterfowl were conducted on each larval-sampling station. Observations and counts of broods and of loafing and feeding adult birds were made while larval samples were being taken. Additional information on wildlife was obtained from the Utah State Fish and Game Department and the Fish and Wildlife Service. Quantitative plant surveys were also conducted on each larval-sampling station.

Water samples were taken periodically from the study areas and were analyzed to determine water quality. The water quality was determined on a basis of biochemical oxygen demand, bacteriological analysis, salinity, and alkalinity. A complete ion analysis was also made at the beginning and end of the mosquito season.

Soil surveys were conducted on the Lake Front Club by personnel of the Soil Conservation Service. The soil was classified and a work plan was developed in which recommendations were made for improving the production of desirable food and cover required for the operation of a successful wildlife area.

A sentinel flock of 30 chickens was established and maintained at Farmington Bay by the Disease Ecology Section, Public Health Service, Greeley, Colorado, during the summer and fall of 1963. Blood samples were taken in October 1963, and examined to determine if antibodies were present for Western Equine and St. Louis Encephalitis viruses. The reports received on the blood samples were negative.

In September 1963, the Weather Bureau in cooperation with the Utah State Department of Fish and Game and the Salt Lake City Mosquito Abatement District installed a class "A" evaporation station at Farmington Bay Waterfowl Management Area. The station will provide climatological data of maximum and minimum daily temperature, daily precipitation, and, from May 1 to September 30, daily measurement of evaporation with supporting measurements on wind movement and humidity. Since very few climatological records are available from the vicinity of the marsh areas near Great Salt Lake, it is assumed this station will provide valuable data during 1964.

Six species of mosquitoes were collected in the larval stage during 1963. These are the same species that were collected during 1962. Six species of adult mosquitoes were collected by means of bite counts and seven species were collected in light traps. One species, *Aedes nigromaculis* (Ludlow), was collected both on bite counts and in light traps in 1963 that was not collected in the 1962 samples. This mosquito was not collected in 1962 or 1963 in the larval stage.

The relative abundance of larval mosquitoes collected changed from a greater abundance of permanent water mosquitoes, *Culex* and *Culiseta*, in 1962 to a greater abundance in 1963 of *Aedes dorsalis* (Meigen), a flood or temporary water mosquito.

Nests of six species of ducks were found in a wide range of habitats. The most common nest found was

[1] This research project is being supported in part by funds provided by the Research and Training Grants Branch, Division of Water Supply and Pollution Control, Public Health Service, Research Grant WP-00027-03.

cinnamon teal (*Anas cyanoptera* Vieillot), followed by redhead (*Aytha americana* (Eyton)), and mallard (*Anas platyrhynchos platyrhynchos* Linn.). Other species found nesting were gadwall (*Anas strepera* Linn.), pintail (*Anas acuta* Linn.), and shoveler (*Spatula clypeata* (Linn.)).

Salt grass (*Distichlis stricta* (Torr.) Rybd.) is the vegetation in which the nests were most commonly found. The salt grass in which extensive nesting was found was that in which there was no standing water during the nesting season. Under these conditions, there was no mosquito production. In salt grass areas which were flooded with water, few nests were found and some of those that were found had been destroyed by the water. Flooded salt grass during the nesting season generally results in prolific mosquito production, especially if the water levels fluctuate. Olney's bulrush (*Scirpus olneyi* A. Gray) was the most important plant used in nesting in the sampled areas where the station was completely flooded.

The American coot (*Fulica americana* Gmelin) was the most numerous bird observed in the waterfowl counts. In the duck counts, the pintail was the most abundant.

In an attempt to evaluate the effectiveness of the water management program on mosquito production on the Lake Front Club, a study was made of the mosquitoes produced on the club property. For comparative information, a similar study was conducted on an adjacent marsh which was comparable in size and similar in physical features to the Lake Front Club but on which water was not objectively managed to reduce mosquito production. To determine the amount of mosquito production occurring on each area during 1963, regular weekly inspections were made on both areas. The number of larval collections of each species was tabulated and the size of each area containing larvae was estimated at the time of inspection.

As a result of this study it was determined that total mosquito production was 49 per cent less and *Aedes dorsalis* production was 65 per cent less on the Lake Front Club than on the adjacent marsh area where the water was not managed for mosquito suppression. Approximately the same results were obtained in 1962 from a similar study conducted on this and adjacent property.

Some of the conclusions suggested as a result of these studies to date are:

1. The facilities and personnel are now adequate to accomplish the stated objectives of the program.

2. Soil and water quality are important limiting factors and must be considered in any development program adopted for this area.

3. A water management program, based upon the multipurpose objectives of water use on each specific unit, should be determined in cooperation with other persons representing all interests concerned.

4. It was demonstrated on the Lake Front Club in 1962, and again in 1963, that the water management program in operation on this club is suitable for maintaining and possibly improving the waterfowl habitat and in greatly reducing mosquito production on this property.

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ADDITIONAL DISTRIBUTIONAL RECORDS FOR UTAH MOSQUITOES WITH NOTES ON BIOLOGY[1]

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In the publication "An Identification Guide to the Mosquitoes of Utah" by Nielsen and Rees (1961) the Utah mosquito fauna was reported at six genera and 40 species. The distribution of each species was listed by county. New distributional records for Utah, including one new state record, *Culex thriambus* Dyar, and several additional county records were reported by Nielsen and Linam (1963). The present paper further expands the known distribution of the mosquito species of Utah.

Larval collections are indicated by (L), adult collections by (A). Collections were made by the authors unless otherwise indicated.

Aedes campestris Dyar and Knab

This species is widely distributed in Daggett County in the northeastern part of the state. Here the species was found in large numbers in pure cultures in highly alkaline pools with muddy, clay bottoms and devoid of visible vegetation. A sulphurous odor emanated from some of these pools. In other pools which contained desert salt grass, *Distichlis stricta*, the species was associated with *Aedes dorsalis* and *Aedes fitchii*. The behavior of the larvae of *A. campestris* is unusual. They hang motionless about 3 to 8 inches under the water surface. In most pools it appears that the great

[1] This investigation was supported by a PHS research grant Al 04121, National Institutes of Health and the University of Utah Research Fund.

majority of larvae present are in this position. Individuals slowly move from time to time to respire at the surface or feed on the sides or bottom. If disturbed, all larvae quickly move to the bottom. The pupae characteristically rest at the surface.

The August collections at Linwood and Manila were determined by ovarian dissection to be newly emerged females. These females were taken in the same area as the May adult and larval collections, and the pools from which they had emerged were located. The pools had produced a May brood of *A. campestris*, had dried up, and then were subsequently reflooded by fluctuations in the water level of a large adjacent marsh. We believe the August collections represent a second brood.

In Utah *A. campestris* appears to be primarily a univoltine species, but is apparently capable of additional broods if the spring pools which produce the first brood dry up and later are reflooded with sufficient water. In Utah the great majority of pools in which *A. campestris* larvae have been collected are the result of melting snow, heavy spring rains, or runoff. Once these pools dry up they are not reformed until the following spring. Chapman (1963) had previously reported a comparable situation in Nevada and proved that the eggs of *A. campestris* females would hatch the same season they were laid.

DAGGETT Co.: Linwood, 6,024 ft., V-19-63 (A, L), VIII-8-63 (A); Manila, 6,300 ft., VIII-8-63 (A).

Aedes cataphylla Dyar

This univoltine species is one of the most abundant and widespread mosquitoes in the state. It is an extremely ubiquitous species in the selection of larval habitats; in Utah it is often found in snow-melt pools in timbered areas up to evelations of 9,000 feet, but occurs with great frequency in spring pools in sagebrush valley and foothill areas, down to elevations of 4,500 feet. The two records listed below are representative of the variability of larval habitats. The larvae representing the first-listed site were collected in a large deep Carex marsh in an open mountain meadow area. The larvae in the second-listed site were collected in a very shallow snow-melt pool within an aspen-yellow pine forest. The bottom was bare except for a sparse growth of grass and *Eleocharis sp.*

In Utah the mosquito species most commonly associated with the larvae of *A. cataphylla* are *A. fitchii, A. implicatus* and *A. increpitus.*

Jenkins (1956) reported *A. cataphylla* as a typical alpine species which occurred in tundra and muskeg areas in arctic and subarctic areas of North America. He believed *A. cataphylla* to be restricted to near timberline in the southern areas of the Rocky Mountains. We have made many collections of *A. cataphylla* in all of the Rocky Mountain states and, although this species sometimes is found in the upper limits of subalpine coniferous areas, the great majority of collections have been made in open foothill or mountain valley areas and in the montane coniferous forests.

DAGGETT Co.: Uinta Mountains, Hwy. 44, 38 mi. No. Vernal, 7,950 ft., V-18-63 (L); Uinta Mountains, 21 mi. So. Manila, Hwy. 44, 8,000 ft., V-18-63.

Aedes fitchii (Felt and Young)

DAGGETT Co.: Uinta Mountains, 21 mi. So. Manila, Hwy. 44, 8,000 ft., V-18-63 (L).

SAN JUAN Co.: Abajo Mountains, Dalton Springs Campground, 8,400 ft., V-25-63 (L).

Aedes implicatus Vockeroth

This species is widely distributed in northern Utah, but is not a common species and rarely occurs in pure cultures. In Utah the larvae are most characteristically associated with *A. cataphylla* and *A. increpitus*, but almost invariably are present in far fewer numbers than either of these two species. Larval habitats in Utah are generally grassy, snow-melt pools in mountain valleys or meadows between 6,000 to 8,500 feet. Pools are usually open or associated with willow growths, rarely in timber.

DAGGETT Co.: Uinta Mountains, Hwy. 44, 38 mi. No. Vernal, 7,950 ft., V-18-63 (L).

Aedes increpitus Dyar

The August collection indicated below is of considerable interest as it represents the latest larval collection of this species known to us. Larvae of *A. increpitus* were taken in large numbers in the same pool on May 5. *Aedes increpitus* is generally recognized as a univoltine species. The August collection consisted of a single fourth instar larva and although the possibility of a second brood exists we believe it more likely that the larva appeared as a result of some factor causing a delayed hatching in the egg.

DAGGETT Co.: Uinta Mountains, Moenkopi Campground, 6,280 ft., V-18-63 (L), VIII-8-63 (L); Manila, 6,376 ft., V-19-63 (L).

Aedes melanimon Dyar

Nielsen and Rees (1961) reported this species from DUCHESNE, GRAND, SALT LAKE, SAN JUAN and UTAH counties. Other published records for Utah have been reported from CACHE and JUAB counties (Richards *et al.*, 1956), DAVIS Co. (Richards, 1956) and UINTAH Co. (Nielsen and Linam, 1963). An additional new record is indicated below.

RICH Co.: Laketown, 5,991 ft., V-23-64 (L).

Aedes nigromaculis (Ludlow)

CARBON Co.: 6½ mi. So. of Wellington, Hwy. 50, 5,500 ft., VIII-31-63 (A).

Aedes schizopinax Dyar

MILLARD Co.: 22 mi. So. Delta, Hwy. 26, 4,500 ft., IV-7-63 (L).

RICH Co.: Bear Lake environs, So. end, 5,935 ft., V-5-63 (L), E. Riley.

Culex apicalis Adams

WASHINGTON Co.: St. George, 2,800 ft., X-19-63 (A), XI-16-63 (A), XII-29-63 (A), IV-26-64 (L).

Culex erythrothorax Dyar

CARBON Co.: 6½ mi. So. Wellington, Hwy. 50, 5,500 ft., VIII-31-63 (L), IX-15-63 (L).

MILLARD Co.: Holden, 5,107 ft., VI-13-58 (A), F. C. Harmston.

Culex pipiens L.

DUCHESNE Co.: 10 mi. So. Duchesne, Hwy. 33, 6,200 ft., VIII-31-63 (L).

EMERY Co.: Elmo, 5,750 ft., VII-29-60 (A), F. C. Harmston.

Culex salinarius Coq.

DAVIS Co.: Farmington Bay, 4,200 ft., VIII-20-62 (L), D. Kiyoguchi.

WEBER Co.: Riverdale, 4,379 ft., III-23-63 (L), D. Nelson.

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UTAH MOSQUITO CONTROL — FISH AND WILDLIFE MANAGEMENT COORDINATION COMMITTEE ANNUAL REPORT OF PROGRESS, 1963

Members of the Committee

J. B. LOW, Leader, Utah Cooperative Wildlife Research Unit, *Chairman*

DON M. REES, Division of Biological Sciences, University of Utah

DONALD M. SMITH, Waterfowl Supervisor, Utah Department of Fish and Game

Associated Agencies

1. Utah Mosquito Abatement Association
2. Utah Department of Fish and Game
3. Bureau of Sport Fisheries and Wildlife
4. Utah Wildlife Federation
5. Wildlife Society (Utah Chapter)
6. University of Utah
7. Utah State University
8. Utah Department of Health
9. Various City and County Health Departments

Objectives of the Committee

1. To work with the National Committee in further serving the aims and objectives of the National Committee on the state and local level.
2. Coordinate mosquito control and fish and wildlife management programs and policies on state and local levels.
3. Gather and disseminate relevant information and suggest standards on mosquito control techniques consistent with sound fish and wildlife management objectives.
4. Gather and disseminate relevant information and suggest standards on fish and wildlife management techniques consistent with sound mosquito control objectives.
5. Stimulate needed research and demonstration projects relating to mosquito control and fish and wildlife management practices.
6. Sponsor suitable meetings and cooperate with agencies, organizations, and all others whose activities and interests may relate to those of this committee.

Progress on 1963 Program

The program for 1963 was listed under eight points. A brief review of the progress on each follows:

1. *Complete the Committee arrangements including areas of district organization that may be deemed necessary.*

   No further organization has taken place in the Committee during the year and the Committee remains the same as when originally organized.

2. *Prepare a list of agencies and groups interested in the subject of mosquito control-wildlife management programs and problems.*

   The Committee has

   (a) prepared a list of agencies and groups interested in the two programs in the State of Utah (this list will be sent out as an information release to those on the mailing list), and

   (b) prepared a mailing list of the agencies, groups, and individuals to which materials will be disseminated. The list includes 13 mosquito-oriented agencies and 40 wildlife agencies on both the state and national level.

3. *Establish a calendar of meetings of the Committee and related group meetings that may be brought to the attention of the membership.*

   The calendar is established and has been sent to the mailing list. However, it is subject to revision as other meetings and conferences come to the attention of the Committee.

4. *Conduct one or more field days on areas of problems or demonstration programs showing progress toward solution of problems.*

   No action.

5. *Establish calendar of associated events and meetings where the subject might be introduced, entertained, or brought to the attention of those present.*

   This point might logically be combined with item 3.

6. *Serve as a clearinghouse for problems of this nature and serve as a source of information dissemination to those wishing mosquito control and wildlife management information.*

   This function has been served to some extent during the past year and will solicit additional attention from the membership during the coming year.

7. *Promote a research program that will assist in closer understanding of the mosquito and wildlife management programs.*

   A master list of research projects having to do with the two areas has been prepared for dissemination to members. This list includes 14 mosquito-oriented projects and 12 wildlife projects. As with the other information this list is subject to continual revision and our mailing list to be alerted.

8. *Prepare information and maps showing the mosquito abatement districts as presently constituted and the areas of developed and natural wildlife interests.*

   The initial map showing mosquito control or abatement districts and state and federal refuges has been prepared and is now ready for distribution. Undoubtedly other maps and sources of information could well be sent out to our list. Newspaper publicity on the various conferences and meetings might well be a function of the individual conferences and their respective organizations. A plea is made to those present and will be made to our mailing-list members also to suggest items, projects, meetings, and conferences that come to their attention. The committee can function best when assisted by all individuals representing their varied interests. Other information badly needed is on programs, projects, and policies where possible areas of conflict may develop. The Committee could function advantageously in trying to avoid any conflict and to bring closer working relationships within the various groups.

Proposed Program of the Committee for 1964

1. To continue the use of "Information Releases" to the membership pointing out
   (a) projects which might be of mutual interest, and
   (b) meetings and conferences that the membership could attend and bring the mosquito control-wildlife subject to the attention of those attending.
2. To serve as a clearinghouse for information on the two subjects.
3. To alert the membership to new programs and points of interest which they may wish to inspect.
4. To conduct field days on areas of problems or demonstrations showing progress toward solutions of problems.

LAWS OF UTAH 1923, AMENDED 1931

CHAPTER 90

S. B. No. 185.

(Passed March 7, 1923. Approved March 16, 1923.

In effect May 8, 1923)

FORMING AND TAXING MOSQUITO ABATEMENT DISTRICTS

An Act to provide for the formation, government, operation and dissolution of mosquito abatement districts in any part of the State, to facilitate the extermination of mosquitoes, flies and other insects; and to provide for the assessment, levy, collection and disbursement of taxes therein.

Be it enacted by the Legislature of the State of Utah:

Section 1. MOSQUITO ABATEMENT DISTRICTS. Mosquito abatement districts may be organized and incorporated and managed as herein expressly provided, and may exercise the powers herein expressly granted or necessarily implied.

Section 2. WHO MAY CREATE. Any city, county, or portion of a city or county, whether such portion includes incorporated territory or not, in the State of Utah, having a population of not less than one hundred inhabitants, may be created a mosquito abatment district under the provisions of this Act by proceeding as herein provided.

Section 3. PETITION — CONTENTS — PUBLICATION — BOUNDARIES—HEARING—COMPLETION. A petition, which may consist of any number of separate instruments, shall be presented at a regular meeting of the board of commissioners of the county in which the proposed mosquito abatement district is located, signed by the registered voters within the boundaries of the proposed district, equal in number, to at least ten per cent of the number of votes cast in said proposed district for the office of governer of this State at the last general election prior to the presenting of the petition; provided, that where one or more municipal corporations or part thereof is included in such proposed mosquito abatement district, such petition must be signed by at least ten per centum of the qualified electors of such municipal corporations or part thereof and of the unincorporated territory included in such proposed district, and in addition thereto the city council, board of trustees or other governing body of each such municipality shall by resolution, duly authenticated, request the inclusion of such incorporated territory in such districts. Such petition shall set forth and describe the proposed boundaries of such district, and shall pray that the same be created under the provisions of this Act, and the text of such petition shall be published for at least two weeks before the time at which the same is to be

presented in a newspaper printed and published in such county, and also a newspaper printed and published in each municipal corporation or part thereof included in such proposed district, and if there be no newspaper published in such county, or municipal corporation, the text of such petition shall be posted for the same length of time as required to be published, in three public places within such municipal corporation or part thereof included in such proposed district, and the text of such petition so published or posted shall have annexed thereto a notice stating the time of the meeting of the board of commissioners at which the same will be presented. When contained upon more than one instrument, one copy only of such petition need be published and posted. No more than five of the names attached to said petition need appear in such publication or posting of said petition and notice, but the number of signers shall be stated.

With such publication there shall also be published, and if posted, there shall also be posted, a notice of the time of the meeting of the board when such petition will be considered, and that all persons interested therein may then appear and be heard. At such time the board of commissioners shall hear the petition and those appearing thereon, and also all protests and objections to the same, and may adjourn such hearing from time to time, not exceeding two months in all. No defect in the contents of the petition or in the title to or form of the notice or signatures, or lack of signatures thereto, shall vitiate any proceedings thereon, provided such petition or petitions have a sufficient number of qualified signatures attached thereto. On the final hearing said board shall make such changes in the proposed boundaries as may be deemed advisable and shall define and establish such boundaries; provided, that if said board deems it proper to include therein any territory not included within the said proposed boundaries, they shall first cause notice of their intention so to do, to be mailed to each owner of land within said territory proposed to be included whose name appears as such on the last completed assessment roll of the county wherein said territory lies, addressed to such owner at his address given on such assessment roll, or if no address is so given, then to his last known address; or if it be not known, then at the county seat of the county in which his land lies, which said notice shall describe the territory so proposed to be included, and shall fix a time, not less than two weeks from the date of mailing thereof, when all persons interested may appear before said board and be heard; and, further provided, that the boundaries lying within a municipal corporation shall not be altered unless a municipal board of such municipal corporation shall, by resolution, assent to the alterations of such boundaries therein.

Upon such hearing of such petition the board shall determine whether or not the public necessity or welfare of the proposed territory and of the inhabitants thereof requires the formations of such district, and shall also determine whether or not said petition complies with the provisions of this Act, and for that purpose must hear all competent and relevant testimony offered in support of or in opposition thereto. A finding of the board of commissioners in favor of the genuineness and sufficiency of the petition and notice shall be final and conclusive against all persons except the State of Utah, upon suit commenced by the attorney general. If, from the testimony adduced before said board, it appears to said board that the public necessity or welfare requires the formation of such district, the said board shall, by an order entered on its minutes, declare such to be its finding, and shall further declare and order that the territory within the boundaries so fixed and determined, be created a mosquito abatement district, under an appropriate name to be selected by said board, which name shall contain the words "Mosquito Abatement District." The county clerk shall immediately cause to be filed with the secretary of State a certified copy of such order of the board of commissioners, and from and after the date of the filing of such certified copy, the district named therein shall be deemed incorporated as a mosquito abatement district, with all the rights, privileges and powers set forth in this Act, and necessarily incident thereto.

Section 4. GOVERNING BOARD — TERMS. Within thirty days after the said filing with the secretary of State of the certificate of incorporation of said district, a governing board of trustees for said district shall be appointed. Said board shall consist of one trustee to be appointed from said district at large by said board of commissioners and of one trustee to be appointed from each municipality in said district by the governing board of such municipality; provided, that if the board of trustees, thereby created shall consist of less than five members, then the board of commissioners shall appoint from such district at large enough additional members to make a board of five trustees; provided further, that if seventy-five per cent or more of the lands in said abatement district are wholly within the boundaries of a city or town, all five members of the board of trustees of said district shall be appointed by the governing board of such municipality. The governing board of such district shall be called "The board of trustees of.....mosquito abatement district." Each trustee appointed by a municipal board shall be an elector of the municipality from which he is appointed, and each appointee of the board of commissioners shall be an elector of the district. All such trustees shall hold office for the term of two years from and after the second days of the calendar year succeeding their appointment; provided, however, that the first board of trustees appointed under the provisions of this Act shall, at their first meeting, so classify themselves by lot that one-half of their number, if the total membership is an even number, and if uneven then that a bare majority of their number, shall go out of office at the expiration of one year and the remainder at the expiration of two years from the second day of the calendar year succeeding their appointment.

Section 5. ORGANIZATION OF BOARD — EXPENSES — VACANCIES — RULES. The members of the board of trustees shall meet on the first Monday subsequent to thirty days after the filing with the secretary of State of the certificate of incorporation of said district and shall organize by the election of one of their members as

president and one thereof as secretary. The members of the board shall serve without compensation except that the necessary expenses of each member for actual traveling expenses on meetings or business connected with said board shall be allowed and paid. In event of the resignation, death or disability of any member, his successor shall be appointed by the board of commissioners if such board originally made such appointment, or by the governing board of the appropriate municipality, if such appointment were originally made by the board of a municipality. The board of trustees shall provide for the time and place of holding its regular meetings, and the manner of calling the same, and shall establish rules for its proceedings; special meetings shall be called by three trustees and notice of the holding thereof shall be given to each member at least three hours before the meeting. All of its sessions, whether regular or special, shall be open to the public and a majority of the members of the board shall constitute a quorum for the transaction of business.

Section 6. (As amended by S.B. No. 39, passed February 17, 1937, in effect May 11, 1937.) POWERS OF BOARD OF TRUSTEES — INTERFERENCE WITH, A CRIME. The Board of trustees of such district shall have power to take all necessary and proper steps for the extermination of mosquitoes, flies and other insects within the district and, subject to the paramount control of the municipal or other public authorities, to abate as nuisances all stagnant pools of water and other breeding places for mosquitoes, flies or other insects within the district or in territory located in any city or county in the state so situated with respect to such district that mosquitoes therefrom may migrate into the district, to enter upon such territory for the purpose of inspection and examination of the same, and to remove therefrom without notice, stagnant water or other breeding places for mosquitoes, flies or other insects; to purchase such supplies and materials and to employ such labor as may be necessary or proper in furtherance of the objects of this title, and, if necessary or proper in the furtherance of the same, to build, construct and thereafter repair and maintain necessary levees, cuts, canals or channels upon any land within the district, and to acquire by purchase, condemnation or other lawful means in the name of the district any necessary lands, rights of way, easements, property or materials requisite or necessary for any of such purposes; to make contracts to indemnify or compensate any owner of land or other property for any injury or damage necessarily caused by the exercise of its powers by this title conferred or arising out of the use, taking or damage of property for any such purpose and generally to do any and all things necessary or incident to the powers hereby granted and to carry out the objects specified herein. It is a misdemeanor for any person to prevent, hinder, delay or interfere with said board in the exercise of its powers or duties, and cities, towns and counties shall have the power by ordinance to declare such acts to be a misdemeanor and prescribe punishment therefor. (Approved February 24, 1937.)

Section 7. ESTIMATE OF MONEY REQUIRED — LEVY — ELECTION — COLLECTION OF TAX — USE. The board of trustees of each mosquito abatement district shall at least fifteen days before the first day of the month in which the board of commissioners of the county in which such district is situate, is required by law to levy the amount of taxes required for county purposes, furnish to the board of commissioners and to the county auditor, respectively, an estimate in writing of the amount of money necessary for all purposes required under the provisions of this Act during the next ensuing fiscal year. The board of commissioners of such county shall thereafter, at the time and in the manner of levying other county, or city and county, taxes, levy upon all of the taxable property within the district and cause to be collected a tax, to be known as the "..... mosquito abatement district tax." The maximum rate of which must not be greater than sufficient to raise the amount estimated to be raised by the said board of trustees of the district, nor in any event shall such tax exceed ten cents on each one hundred dollars of taxable property in such district.

Whenever it appears to the board of trustese of such district that the amount of funds required during the next ensuing fiscal year shall exceed the maximum amount which the commissioners are authorized to levy for the annual district tax, as hereinabove in this section provided, that said board of trustees may in their judgment call an election and submit to the electors of the district the question of whether a tax shall be voted for raising the necessary additional funds, and notice thereof shall be published for at least four weeks prior to such election in a newspaper printed and published in such district; provided, that no particular form of ballot shall be required nor shall any (in) formalities in conducting such election invalidate the same, if the election shall have otherwise been fairly conducted. At such election the ballots must contain the words, "Shall the district vote a tax to raise the additional sum of $.....?" The board of trustees shall canvass said votes cast at such election and if a majority of the votes cast are in favor of the imposition of said tax the board of trustees must report the same to the board of commissioners, stating the additional amounts of money required to be raised. The board of commissioners, shall at the time of levying the county taxes, levy an additional tax upon all of the taxable property in the district voting such additional tax sufficient to raise the amount voted.

All taxes levied under the provisions of this section shall be computed and entered on the county assessment roll by the county auditor, and collected at the same time and in the same manner as State and county taxes; and when collected shall be paid into the county treasury for the use of the district.

The funds shall be withdrawn from the county treasury upon the warrant of the board of trustees of such district signed by the president or acting president of the board, and countersigned by its secretary.

Section 8. ANNEXING CONTIGUOUS TERRITORY — NOTICE — PUBLICATION — IN MUNICIPALITY. Any territory, incorporated or unincorporated, lying adjacent and contiguous to a mosquito abatement district, may be added and annexed to such district at any time, upon proceedings being had and taken as in this Act pro-

vided. The board of trustees of such district, upon receiving a written petition therefor containing a description of the new territory sought to be annexed to such district, signed by the owners comprising more than one-half of the assessed value of such territory as shown by the last county assessment roll, must thereupon submit to the electors of the district and also to the electors residing in the territory sought to be annexed, the proposition of whether such proposed territory shall be annexed and added to such district. The proposition to be submitted to the electors at such election, both within said district and within said territory so proposed to be annexed, shall be as follows: "For annexation," or "Against annexation," or words equivalent thereto. Such election must be called and held, and notice thereof shall be published for at least four weeks prior to such election in a newspaper printed and published in such district, and also in a newspaper printed and published in such territory so proposed to be annexed. The board of trustees shall canvass, separately, the votes cast within said district, and the votes cast within said territory so proposed to be annexed, and if it shall appear from such canvass that a majority of all the ballots cast in such district and a majority of all the ballots cast in such territory so proposed to be annexed are in favor of annexation, the board of trustees shall certify such facts to the secretary of State describing said property proposed to be annexed and upon receipt of such last mentioned certificate, the secretary of State shall thereupon issue his certificate reciting that the territory (describing the same) has been annexed and added to the.....mosquito abatement district (naming it), and a copy of such certificate of the secretary of State shall be transmitted to and filed with the county clerk of the county in which such mosquito abatement district is situated. From and after the date of such certificate the territory named therein shall be deemed added and annexed to and form a part of said mosquito abatement district, with all the rights, privileges and powers set forth in this Act and necessarily incident thereto. If the property so proposed to be annexed is included within a municipality, consent to such annexation shall first be obtained from the governing board of such municipality, and an authenticated copy of the resolution or order of such board so consenting to such annexation, shall be attached to the petition, and be made a part thereof.

Section 9. DISSOLUTION OF DISTRICT — DISPOSITION OF PROPERTY. The district may at any time be dissolved upon the vote of two-thirds of the qualified electors thereof, upon an election called by its board of trustees upon the question of dissolution, and the proposition which shall be submitted to the electors at such election shall be as follows: "Shall the district be dissolved?" Such election must be called and held; and notice thereof shall be published for at least four weeks prior to such election in a newspaper printed and published in such district. If two-thirds of the votes at such election shall be in favor of the dissolution of the district, the board of trustees shall certify such fact to the secretary of State, and upon receipt of such last mentioned certificate, the secretary of State shall thereupon issue his certificate reciting that the mosquito abatement district (naming it) has been dissolved, and a copy of such certificate of the secretary of State shall be transmitted to and filed with the county clerk of the county in which such mosquito abatement district is situated. From and after the date of such certificate the district named therein shall be deemed disincorporated, and the property of the district shall thereupon vest in the county wherein said district (is) situate, if the district at the time of its dissolution comprises unincorporated territory alone, and if it comprises incorporated territory alone, or partly incorporated and partly unincorporated territory, then in such event its property shall be ratably apportioned amongst the several municipalities and the county in proportion to the assessed value of the property included within said district as shown upon the last county assessment roll; provided, however, that any real property, easements or rights of way, belonging to said district shall in such event remain the property of the municipality wherein the same is situate, if situated within incorporated territory, otherwise the same shall remain the property of the county.

Section 10. WHAT CONSTITUTES PUBLICATION. Every notice herein required to be published may be published in a daily or weekly or semi-weekly newspaper; and if there is no daily or weekly or semi-weekly newspaper published within the district or within a subdivision thereof or other territory wherein the same is required to be published, then such notice shall be posted for the length of time herein required for the publication of the same in three public places of such district or such subdivision thereof or such other territory as the case may be. The term "municipality," as used in this Act, shall include a consolidated city and county, city or town, and shall be understood and so construed as to include, and is hereby declared to include all corporations heretofore organized and now existing, and those hereafter organized, for municipal purposes. The word "district" shall apply, unless otherwise expressed or used, to a mosquito abatement district formed under the provisions of this Act, and the word "trustees," and the words "board of trustees," shall apply to the trustees and the board of trustees of such district.

Section 11. "UNCONSTITUTIONAL" RESERVATION. If any section, subsection, sentence, clause or phrase of this Act is for any reason held to be unconstitutional, such decision shall not affect the validity of the remaining portions of this Act. The legislature hereby declares that it would have passed this Act, and each section, subsection, sentence, clause and phrase thereof, irrespective of the fact that any one or more other sections, subsections, sentences, clauses or phrases be declared unconstitutional.

Approved March 16, 1923.

Amendments approved March 23, 1931.